GRAZING ON NATIONAL FOREST SYSTEM LANDS:

COST OF INCREASING CAPACITY IN THE NORTHERN REGION

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USDA Forest Service
Research Paper INT-215
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE

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October 1978

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RESEARCH SUMMARY

Sample grazing allotments on Ranger Districts in the Northern Region (USDA Forest Service) were surveyed by questionnaire to determine the feasibility of increasing grazing capacity through additional range improvements. The survey included an inventory of existing grazing capacity and the specific kind and cost of proposed improvements. Costs of improvements were amortized and aggregated for each Forest Service Planning Area. The resulting costs were compared with the increased grazing capacity measured in animal unit months (AUM) to determine the cost per additional unit of capacity.

The results show opportunities to increase grazing capacity by 360,000 AUM over the current capacity of 1,175,000 AUM on National Forests in the Northern Region through investment of $23,300,000. Amortized cost per AUM for improvements ranges from $6 in the eastern part of the Region to $16 in the west, as shown in the following table.

Cost of improvements, additional grazing capacity, and amortized cost per AUM by planning area

Planning area	Current cost of additional grazing capacity	Additional grazing capacity	Amortized cost per additional AUM
	Dollars	AUM	Dollars/AUM
N. Idaho	1,573,600	20,650	15.0
W. Montana	2,312,171	21,473	16.0
Cent. Montana	5,967,161	102,717	8.0
Cent. Rocky Mt.	905,951	11,638	9.6
E. Montana	3,465,628	42,161	8.8
Dakotas	9,101,032	165,936	6.1

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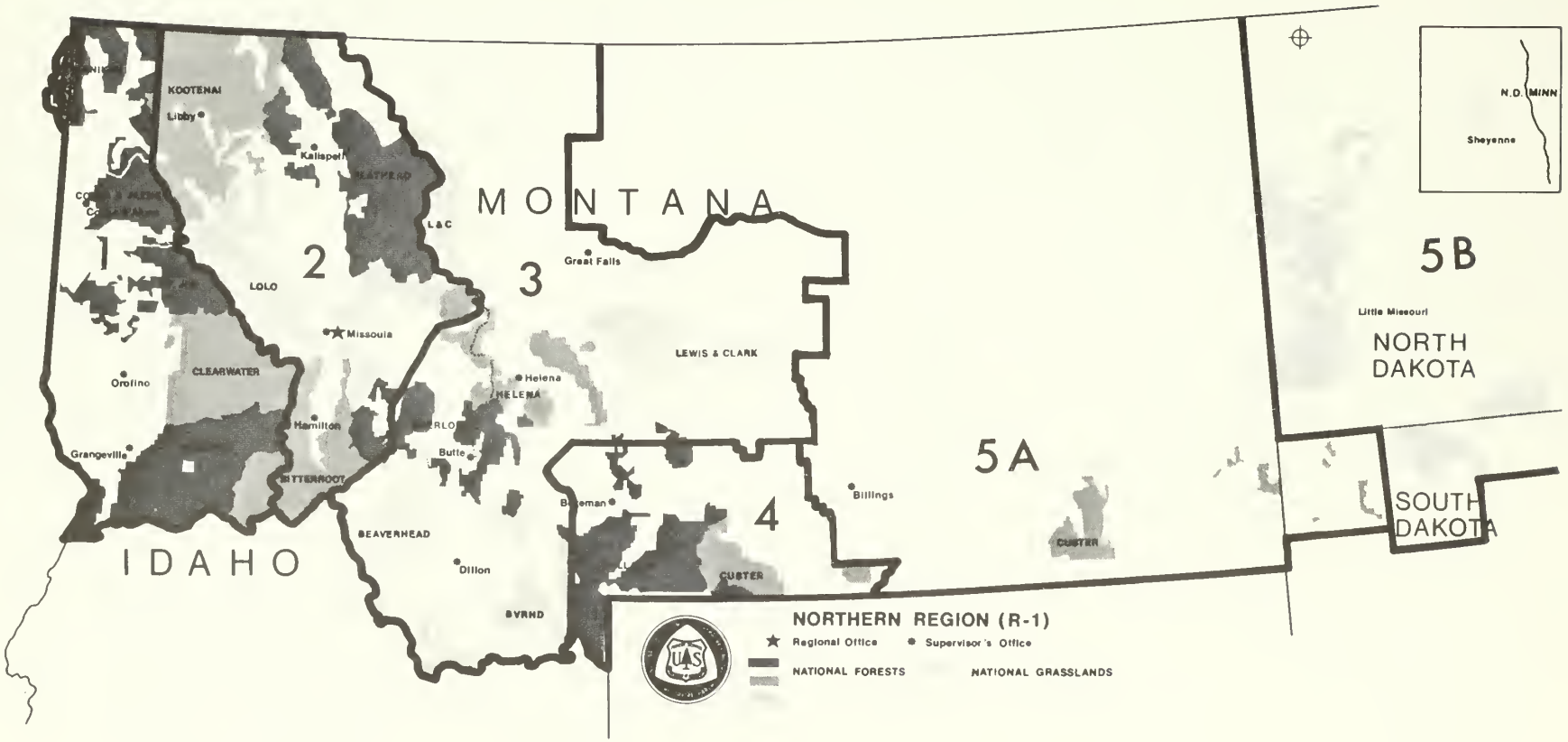

Figure 1.--Location of Northern Region Planning Areas.

INTRODUCTION

In 1974, the Forest and Rangeland Renewable Resources Planning Act was passed by Congress to assure long-range planning of the Nation's renewable resources. One provision of this Act requires:

> An inventory, based on information developed by the Forest Service and other Federal agencies, of present and potential renewable resources, and an evaluation for improving their yield of tangible and intangible goods and services...

In partial response to this provision, this study provides estimates of increased grazing capacity from various range improvement practices in the Northern Region of the Forest Service, U.S. Department of Agriculture. Costs of both the historical and the proposed improvements are also presented.

The Northern Region stretches across rugged northern Idaho, through Montana, and across the Northern Plains of the Dakotas. It extends about 1,000 miles from west to east and, at the extremes, nearly 400 miles from north to south. Because of the variety of conditions in such a large area, findings of this study are presented separately for each of five Planning Areas (fig. 1), defined by common topographic, vegetative, and climatic conditions and having generally comparable range conditions. These areas correspond with those used in the Forest Service planning process and thus facilitate the use of the findings for planning purposes. To the extent possible, findings are also presented for indivldual National Forests. While the Planning Areas include all lands, regardless of ownership, in the Northern Region, this study is only concerned with National Forest lands. Selected descriptors of the Planning Areas are shown in table 0-1.

Table 0-1.--Sampled and total populations and sample expansion factors

Planning areas	Ranger Districts	Number of allotments: Total	Number of allotments: Percent in sample	Net acreage in grazing: Total (Acres)	Net acreage in grazing: Percent in sample	Current grazing capacity: Total (AUM)	Current grazing capacity: Percent in sample	Sample expansion factor 2/
PLANNING AREA 1								
Clearwater NF	6	59	16.9	128,938	32.4	8,517	31.6	3.16
Panhandle NF	8	59	18.6	119,244	42.5	7,601	36.3	2.76
Nezperce NF	6	56	17.9	629,916	31.5	36,649	25.3	3.95
PLANNING AREA 2								
Bitterroot NF	4	64	12.5	176,449	28.6	11,292	23.1	4.33
Flathead NF	5	27	7.4	89,819	24.2	2,748	34.3	2.91
Kootenai NF	7	53	22.6	107,237	33.7	10,755	28.5	3.51
Lolo NF	6	108	11.1	184,863	45.8	11,775	23.1	4.33
Philipsburg RD 3/	1	28	7.1	74,900	70.0	9,319	13.1	7.63
Lincoln RD 4/	1	16	12.5	24,703	41.3	4,949	7.5	13.31
PLANNING AREA 3								
Beaverhead NF	5	199	15.1	639,110	28.9	174,349	15.5	6.47
Lewis & Clark NF	6	160	7.5	350,228	14.5	51,957	10.2	9.82
Deerlodge NF	3	94	6.4	293,829	36.4	39,119	12.2	8.22
Helena NF	3	78	7.7	210,188	14.1	33,624	10.9	9.18
PLANNING AREA 4								
Gallatin NF	6	170	6.5	297,056	10.1	35,836	10.1	9.94
Beartooth RD 5/	1	28	7.1	45,610	15.4	14,507	14.1	7.07
PLANNING AREA 5A								
Custer, 3 RD's	3	116	15.5	506,736	30.1	164,545	27.2	3.68
PLANNING AREA 5B								
Custer, 4 RD's	4	608	7.2	1,123,338	16.4	557,420	17.1	5.85
REGIONAL TOTALS	75	1,923	1/ 10.3	5,002,164	25.8	1,174,962	18.0	5.55

1/ Because 11 sampled allotments were on transitory ranges, four Ranger Districts had no allotments; they were dropped from the sample. There were, then, data from a total of 198 allotments across the Region.

2/ (Sample expansion factor) = (1.) ÷ (Proportion of total current grazing capacity in sample)

3/ Deerlodge National Forest.

4/ Helena National Forest.

5/ Custer National Forest.

STUDY METHODS AND DATA BASE

Data concerning grazing capacity under current levels of investment, the grazing capacities under an intensive level of investment, and the costs of making these investments were collected from each Ranger District by questionnaire (sample questionnaire available from authors). This information was obtained directly from the individuals with on-the-ground responsibility for grazing management, on the assumption they are most familiar with local conditions and best able to make such estimates.

Respondents were instructed to analyze at least two representative or average grazing allotments in their respective Districts that would draw an average amount of cooperation from permittees in sharing expenses of investments. In addition to providing general descriptive information they estimated the current costs and numbers of units of 38 types of structural and nonstructural improvements needed to fully utilize the grazing capacity of each sampled allotment (see appendix B for investment definitions). In addition, they specified the percentage contribution to the total increase in grazing capacity to be expected from each such improvement and the priority for each improvement.

These sample estimates were then expanded to estimate the proposed improvements, by type of improvement, for each Planning Area. We also developed cost estimates for each additional AUM of capacity by type of improvement. The average investment costs per AUM for the intensive investment program were then compared with the investment costs per AUM of the current grazing capacity. Finally, we summarized this information for the Region as a whole in terms of a supply curve.

Representativeness and Expansion of Sampled Allotments

Because of the variety of physical conditions on individual allotments across the Region and the local importance of grazing on the National Forests, we chose to survey each Ranger District in the Region. While two allotments were surveyed on most Ranger Districts, the Districts on the Beaverhead and Custer National Forests (except the Beartooth) were sampled at a rate of 6 to 18 allotments per Ranger District because of the larger number of allotments there. Furthermore, 11 sampled allotments on the Clearwater, Panhandle, Nezperce, Flathead, Gallatin, and Kootenai National Forests were removed because they were transitory range. Transitory range was dropped from the sample because it has few improvements and no permanent grazing capacity, and is generally not considered for investments. In nine other situations allotments were not sampled because none existed. The final sample used in this study contained data from 198 allotments on 66 of the 75 Ranger Districts in the Region.

As shown in table 0-1, the sample covered more than 1 million of the 5 million acres that are grazed. Sampled allotments included 10 percent of the Region's 1,923 allotments and 18 percent of the total grazing capacity under current levels of investment. Because the percentage of net acreage in grazing represented by the sample (26 percent) is somewhat larger than the percentage of the current grazing capacity represented by the sample (18 percent), the productivity estimates of the investments for range improvements in the Region may be somewhat conservative.

We based expansion of our sample on current grazing capacity. Grazing capacity is an estimate of the maximum average number of AUM that can be supported without damaging the range resource and, for each allotment, is a constant for a given management system and set of improvements. In contrast, actual use fluctuates from year to year in response to weather conditions and, perhaps, in response to the market demand for livestock.

It would have been more desirable to weight our sample data concerning improvements necessary to move from the current to a higher capacity by the differences between those capacities. Unfortunately, the higher capacities were not known in advance of this study; indeed, estimates of the higher capacities are one result of this study.

For any grouping of similar Ranger Districts, we expanded our sample in the following manner:

$$\begin{bmatrix}\text{Sample}\\ \text{expansion}\\ \text{factor}\end{bmatrix} = \left[\frac{1.0}{(\text{Proportion of current grazing capacity in sample})}\right]$$

For the Bitterroot National Forest in Planning Area 2, then

$$\begin{bmatrix}\text{Sample}\\ \text{expansion}\\ \text{factor}\end{bmatrix} = \left[\frac{1.0}{0.231}\right]$$

$$= [4.33]$$

If three cattleguards were proposed for the allotments sampled on the Bitterroot, for example, we calculated

$$\begin{bmatrix}\text{Total number}\\ \text{cattleguards}\\ \text{proposed for Bitterroot}\end{bmatrix} = \begin{bmatrix}\text{Number proposed}\\ \text{for sample}\\ \text{allotments}\end{bmatrix} \times \begin{bmatrix}\text{Sample}\\ \text{expansion}\\ \text{factor}\end{bmatrix}$$

$$= [3] \times [4.33]$$

$$= 12.99 \text{ or } 13$$

To the extent possible, sample expansion factors were calculated for individual National Forests. Where National Forests were split between Planning Areas, sample expansion factors were calculated for Ranger Districts.

Primary Data

By questionnaire we developed the following principal types of primary data for each sampled allotment:

Type of information	*Comment*
Proposed range improvements	The questionnaires reported the specific kinds of improvements necessary to increase grazing capacity; because the sizes and materials necessary for structural improvements varied a good bit by allotment, we categorized the improvements by their functions for use in cost comparisons between Planning Areas (e.g., cattleguards, stock trails, and stock bridges were categorized as "Access" improvements).

Type of information	*Comment*
Local costs prevailing in early 1976 to construct or implement one unit of each kind of improvement.	For examining proposed improvements for a given National Forest, we used the average cost of the sampled allotments on that Forest. Because current costs are not available for certain improvements on particular Forests, we used the average costs from all allotments within a Planning Area to calculate the replacement costs of historical improvements. Where current costs were not available for a Planning Unit, we used average costs in the Region.
Increase in grazing capacity for entire allotment given entire package of proposed improvements; percentage of increase due to each category of improvement.	Improvements were considered as "packages" of investments and do not, on particular allotments, permit an increase in grazing capacity by themselves; however, at the Planning Area level we have aggregated the information to provide rough measures of expected productivity of each category of investment.

Secondary Data

To supplement the primary survey data gathered for this study, we assembled certain background information. The principal types of information, their sources, and the manner in which they are used in this report are:

Type of Information	*Source*	*Manner of use*
Historical expenditures for range improvements.	Regional Office[1]	Determine proportions contributed by permittees, Forest Service, and other Government sources.
1975 inventory of historical range improvements.	Regional Office[1]	Determine replacement costs of improvements supporting present grazing; contrast with costs of proposed improvements.
Amortization schedules for range improvements.	FRES study and interest tables[2]	Determine average annual cost of improvements using an interest rate of 10 percent.

[1]USDA Forest Service. 1975. Statistical summation of range improvements. Computer printout of range inventory of existing improvements and accounts of cumulative investments by Ranger District and National Forest, March 24, 1975, USDA-FS, R-1, Missoula, Montana. (Unpublished computer printout).

[2]See Duran and Kaiser (1972) regarding FRES, and Lundgren (1971, p. 115) for interest formula and tables.

Type of information	*Source*	*Manner of use*
Current grazing capacity, 1975 actual grazing, physical descriptors.	Sampled allotments and individual National Forests	Determine current average costs per AUM and general descriptions.
Data on ranch sizes and Planning Area populations.	Census[3]	General descriptions.

Calculating Procedures

This study considers a large number of improvements over many administrative units in the Northern Region. In each of the sections of this report that are devoted to a single Planning Area, the calculations shown in Table 0-2 were used to evaluate the productivity of historical and proposed range improvements. The detail available for the sampled allotments was foregone to derive averages at the Planning Area level. Because basic information is lacking, it is not possible to estimate the productivity of individual categories of historical improvements. Throughout this study, replacement and current costs are expressed in terms of 1976 dollars.

Each of the following sections contains a similar set of tables. To thoroughly understand the way in which the table entries were derived, we urge the reader to carefully read the section covering Planning Area 1, for the methodology is presented in more detail there than in the other sections. The Regional summary simply abstracts data from the other sections.

Table 0-2.--Calculations to evaluate historical and proposed improvements

Level of information	Historical improvements	Proposed improvements
1. Kind of improvement	[Replacement cost of improvements] = [1975 R.O. inventory] X [Current Planning Area average cost]	[Cost of improvements] = [Expansions of proposed improvements from questionnaires] X [Current National Forest average cost]
2. Category of improvement	Sum replacement costs to get replacement cost of category of improvements.	Sum costs to get cost of category of improvements
3. Category of improvement	[Amortized replacement cost of category] = [Replacement cost of category] X [Ten percent Interest-payment factor 1/]	[Amortized cost of category] = [Cost of category] X [Ten percent Interest-payment factor 1/]
4. Category of improvement	-- -- -- -- -- -- -- -- -- -- --	Amortized cost of category per additional AUM = Amortized cost of category ÷ Additional grazing capacity due to category
5. All improvements	Sum to get amortized replacement cost of all improvements.	Sum to get total amortized cost per added AUM.
6. All improvements	[Total amortized replacement costs per current AUM] = [Total amortized replacement costs] ÷ [Total current grazing capacity]	-- -- -- -- -- -- -- -- -- -- -- -- --

1/ See Appendix D.

[3]Population from U.S. Bureau of the Census (1973, p. 28-31) and farm data from U.S. Bureau of the Census (1972, p. 253).

Interpreting the Results

Care must be taken in interpreting the results presented in the following chapters. First, most of the data were obtained as subjective estimates, albeit by professionals, and therefore may not be as consistent or precise as desired. Nevertheless, these are the best data available Regionwide.

Second, not all opportunities for range improvements may be represented. Because the sample is biased toward the poorer quality range, the data may show fewer, less productive improvements than is actually the case. Furthermore, some of the interviewers appeared to be more imaginative in perceiving new opportunities than others. Thus, the opportunities addressed in this study probably do not include all that actually exist.

Third, for the improvement opportunities that were considered, not all the associated costs were recorded. Those concerned with administration and maintenance for the allotments were omitted. To the extent that these costs increase with increasing intensity of management, the cost estimates presented in this study are low. Another cost problem involves differences in cost among Forests and Planning Areas for the same improvement. For example, on the Deerlodge National Forest one type of fence costs $4,000 per mile while a similar fence costs less than $2,000 per mile on the Beaverhead. Similar costs variations can be found in most of the other improvement categories. While a small amount of this variation may be attributed to error in estimation, we believe most of the variation reflects differences in materials, terrain, design, and other related factors.

A fourth consideration in interpreting the results deals with projections of AUM associated with improvement opportunities. Not all of the increases in production will be available to cattle, because some forage for wildlife is also a Forest Service objective. Furthermore, in some cases the improvements are necessary just to maintain an allotment's present grazing capacity and no increase in yields will result.

Fifth, because of the joint nature of some proposed improvements, comparing data for individual improvement categories is rather risky, especially at the Forest level. For instance, fencing on a particular National Forest might be attractively efficient compared to water development. However, fencing without water development might be useless. Because of this problem, the summary chapter does not attempt to judge the efficiency of individual improvement opportunities.

A final consideration involves the problems of interpreting the historical cost data which are presented in terms of 1976 dollars. Age of the improvements was not available nor was the expected length of use. Thus, the replacement cost was calculated assuming all past improvements would be redone and would last as long as the proposed improvements. This procedure may lead to double counting where past improvements replaced previous improvements. Offsetting this effect is the fact that some range improvements have probably not been recorded and thus not counted in this study. In the case of the National Grasslands, some costs may be omitted, because records were available only since the Forest Service assumed administration.

In spite of these limitations, we feel the results in the following sections represent the best data available at this time for the Northern Region. They can serve as useful indicators of relative opportunities, their costs, and their productivity for planning purposes.

PLANNING AREA 1: NORTHERN IDAHO

Planning Area 1 covers northern Idaho and includes the Idaho Panhandle, the Clearwater, and the Nezperce National Forests. Grazing is limited to 878,000 acres (14 percent) of the total 6.2 million acres. In 1975, 174 allotments were grazed by 226 permittees, representing 5.5 percent of the 4,095 farms and ranches in the area. Livestock grazing was concentrated on the Nezperce, the southernmost forest, with 32,000 AUM. There were about 8,400 AUM on the Clearwater and 5,400 AUM on the Panhandle. Total actual grazing in this area accounted for slightly more than 4 percent of the Region's total in 1975, and the grazing capacity accounted for about 4.5 percent of the Region's total. Selected descriptors of the area are presented in table 1-1.

Historical Improvements

Past investments have been made in a variety of improvements to permit utilization of the range resources in the Planning Area. The range improvements in Planning Area 1 are summarized in table 1-2. Generally, investments have been made primarily in cattleguards, water, fences, and cabins. Few investments in range improvement practices have been made.

Table 1-1.--Selected descriptors of Planning Area 1, 1975

National Forest	Number of allotments	Number of Permittees	Total net acreage	Net grazing acreage: Total	Net grazing acreage: Percent under timber canopy	Current grazing capacity
						AUM
Clearwater	59	77	1,825,690	128,938	60	8,517
Panhandle	59	76	2,208,784	119,244	74	7,601
Nezperce	56	73	2,150,498	629,916	88	36,649
Planning Area Total	174	226	6,184,972	878,098	82	52,767
Planning Area as percent of Northern Region	9	10	26	18	--	4

Table 1-2.--Number of historical improvements in Planning Area 1 by National Forests

Kind of Improvement	Clearwater N.F.	Panhandle N.F.	Nezperce N.F.	Planning Area 1 Total Number
STRUCTURAL				
A 1. Cattleguard	19	18	26	63
2. Stock trail(miles)	12.8	4.8	62.8	80.4
3. Stock bridge			8	8
B 4-5. Rain tanks			6	6
C 6-8. Spring tanks	1		215	216
E 13-14 Water trans'm (miles)		3.1		3.1
F 15. Dam & reservoir	17		11	28
G 16. Other water dev.		2		2
H 17-21. Fence (miles)	26.3	16.4	139.5	182.3
I 22. Cabin	4	1	23	28
Barn	2		2	4
Corral	8	2	27	37
Loading chute	5		1	6
Dipping vat		1		1
NONSTRUCTURAL				
J 1-2. Ground prep(ac)		25		25
K 3-6. Seeding(ac)	12	18	230	260
L 7-8. Fertilizer(ac)	3	20		23
N 11-14. Plant Control(ac)	312	95		407

Replacement Costs and Productivity

The present grazing capacity is, in part, dependent upon the investments already on the ground. The inventory of present improvements and the costs required to replace them, based on the current prices found in this study, are itemized in table 1-3. The total replacement cost would be about three-quarters of a million dollars.

The last column in table 1-3 lists the equivalent annual investments that would be required to replace the historical level of improvements. In total this is approximately $90,000 per year. A rough index of the productivity of these improvements can be obtained by dividing the amortized value by the grazing capacity.

Grazing capacity	52,767 AUM
Total amortized cost of improvements	$90,391
Cost per AUM	$1.71

Table 1-3.--Calculation of total and amortized replacement costs of historical improvements in Planning Area 1

	Type of improvement	Existing number	Replacement cost Per Unit	Replacement cost Total	Category replacement cost	Useful life	Amortized replacement cost
			Dollars		Dollars	(Years)	Dollars
A	1 Cattleguard	63	1352	85,176			
	2 Stock trail (mi)	80.4	518	41,647	168,823	40	17,264
	3 Stock bridge	8	5250	42,000			
B	Tanks	6	1300	7,800	7,800	30	827
C	Spring, tanks	216	486	104,976	104,976	30	11,136
E	Water transmission (mi)	3.1	1152	3,571	3,571	30	379
F	Dam & reservoir	28	965	27,020	27,020	30	2,866
G	Other water develop.	2	157	314	314	30	33
H	Fence (mi)	182.3	1119	203,994	203,994	25	22,474
I	Cabin	28	5000	140,000			
	Barn	4	5000	20,000			
	Corral	37	1000	37,000	200,500	10	32,630
	Loading chute	6	500	3,000			
	Dipping vat	1	500	500			
Structural Subtotal				716,998			87,609
J	Ground preparation (ac)	25	100	2,500	2,500	5	659
K	Seeding (ac)	260	12	3,120	3,120	30	331
L	Fertilizer (ac)	23	23	529	529	3	213
N	Plant control (ac)	407	30	12,011	12,011	15	1,579
Nonstructural Subtotal				18,160			2,782
GRAND TOTAL				735,158			90,391

In the past, a very simple, extensive range management has been practiced. Essentially, fences bounded the allotments and the cattle ate whatever forage occurred naturally. To add more cattle in any area requires investing in relatively expensive improvements such as fertilization, shrub control, and water developments. Most of the rest of this chapter discusses estimates of expected costs and results of increasing grazing capacity beyond present levels.

Past Expenditures

Past expenditures in Planning Area 1 amounted to only 9 percent of the Region's range management expenditures (table 1-4). However, since the Area supports only 4 percent of the grazing capacity, this is not surprising. Most of the funds have come from sources other than the range improvement accounts such as Job Corps, fire crews, and particularly range administration. About one-fifth has come from the Forest Service range improvement accounts and the permittees in roughly equal amounts.

Table 1-4.--Historical expenditures for improvements in Planning Area 1 in total and as a percentage of total expenditures in the Northern Region by sources of funds

Sources of funds	Expenditures	
	Dollars	As percentage of expenditures in Region
Forest Service range improvements	153,900	4
Other Forest Service[1/]	620,200	25
Permittees	151,400	5
ALL	925,500	9

1/ Includes all Federal Government expenditures not included in Forest Service range accounts 052 and 053 including range administration and planning, Job Corps, fire crew, etc.

Proposed Improvements

The sampling methodology used in this study was discussed earlier. Between 25 and 40 percent of actual grazing use and current carrying capacities were sampled on the three forests making up this Planning Area. The 33 sampled allotments indicate there is the potential to increase the Area's carrying capacity by more than a third.

Estimates of the specific kinds of proposed investments and their costs are detailed, by National Forests, in table 1-5. The projected Planning Area total cost for structural improvements is $712,000 with the Nezperce comprising about half the total. Emphasis is centered on fencing and improvements to facilitate access. Nonstructural improvements would cost about $860,000, with the Nezperce again comprising over half. Seeding, fertilization, and plant control are the major items.

The particular kinds of improvements requested for each sample allotment are a function of already existing improvements; local physical and climatic conditions; and, to some extent, the inclinations of the permittees to share in costs. Even within many of the categories listed in table 1-5, there is substantial variation. For example, cattleguards can be made of railroad rails or 2- by 8-inch planks and can vary from 9 to 24 feet in length. As a consequence, the cost for cattleguards varies substantially. On the Clearwater National Forest (which includes two sample allotments), the cost per cattleguard averaged about $2,556 ($23,000 ÷ 9), on the Panhandle about $2,250, and on the Nezperce about $995.

A comparison of the replacement costs of historical improvements to the cost of proposed improvements suggest a change in emphasis:

	Replacement cost of existing improvements	*Cost of proposed improvements*
Structural	98	45
Nonstructural	2	55

Table 1-5.--Proposed improvements and their costs on sampled allotments and estimates for Planning Area 1

Type of improvement	Unit	Sampled allotments: Clearwater N.F. Units	Clearwater N.F. Cost	Panhandle N.F. Units	Panhandle N.F. Cost	Nezperce N.F. Units	Nezperce N.F. Cost	Expansion to N.F.s 1/: Clearwater N.F. Units	Clearwater N.F. Cost	Panhandle N.F. Units	Panhandle N.F. Cost	Nezperce N.F. Units	Nezperce N.F. Cost	Planning Area 1 Total cost
			Dollars		Dollars		Dollars		Dollars		Dollars		Dollars	Dollars
STRUCTURAL IMPROVEMENTS														
ACCESS														
A 1 Cattleguard	each	9	23,000	4	9,000	31	30,850	28	71,568	11	24,750	122	121,390	217,708
2 Stock trail	mile	6.0	2,500			1.0	1,000	19.0	7,923			4.0	4,000	11,923
3 Stock bridge	each					2	10,500					8	42,000	42,000
WATER DEVELOPMENTS														
C 7 Spring, metal tank	each	7	3,500			9	4,300	22	11,000			36	17,208	28,208
F 15 Dam & reservoir	each	4	4,800			1	200	13	15,600			4	800	16,400
G 16 Other water development	each	7	1,100					22	3,454					3,454
FENCE														
H 17 Boundary, N.F.	mile	2.7	6,200	2.0	3,000	10.1	10,000	8.5	19,516	5.5	8,250	39.5	39,500	67,266
18 Boundary, allotment	mile	7.0	10,800	3.0	5,000	5.5	6,500	22.2	34,255	8.3	13,836	21.7	25,649	73,740
19 Interior, allotment	mile	15.0	12,400	4.7	7,400	35.5	32,850	47.5	39,282	13.0	20,462	140.3	129,778	189,522
20 Water source	mile	1.0	5,000					3.2	16,000					16,000
21 Right-of-way	mile													
I 22 Miscellaneous structural			5,000		11,000				15,822		30,303			46,125
Structural subtotal			74,300		35,400		96,200		234,420		97,601		380,325	712,346
NONSTRUCTURAL IMPROVEMENTS														
GROUND PREPARATION														
J 1 Plowing	acres	5	500					16	1,600					1,600
SEEDING														
K 3 Broadcast, ground	acres	5	200			20	300	16	640			79	1,185	1,825
4 Broadast, air	acres	2,000	10,000			1,400	27,500	6,329	31,645			5,534	110,680	142,325
6 Interseed	acres					200	2,000					791	7,910	7,910
FERTILIZATION														
L 7 Plant establishment	acres	5	50					16	160					160
8 Increase production	acres	2,800	47,500			500	26,000	8,861	150,637			1,976	102,752	253,389
PLANT CONTROL														
N 11 Burning	acres	15	3,000					48	9,600					9,600
12 Mechanical	acres					200	10,000					791	39,550	39,550
13 Chemical	acres	1,305	21,300	657	22,995	1,420	42,700	4,130	66,080	1,810	63,350	5,631	168,930	298,360
14 Hand	acres	300	15,000					949	47,450					47,450
O 15 Rodent control	acres	100	1,000			25	500	316	3,160			99	1,980	5,140
P 16 Miscellaneous nonstructural			14,000		3,500				44,303		9,642			53,945
Nonstructural subtotal			112,550		26,495		109,000		355,275		72,992		432,987	861,254
GRAND TOTAL			186,850		61,895		205,200		589,695		170,593		813,312	1,573,600

1/ Calculated by multiplying sample data on physical improvements for each National Forest by sample expansion factors in Table 1. This product was rounded off and then multiplied by the average unit price for each National Forest.

Apparently a substantial increase in nonstructural improvements is called for. However, some of this difference is probably due to the fact that nonstructural treatments were more likely to be overlooked in the survey of historical improvements than readily identifiable structural features. This situation also applies to similar interpretations in later chapters. Still some shift in emphasis is apparent.

Productivity of Proposed Improvements

The range specialists also indicated the proportion of each allotment's total increase in grazing capacity, given requested improvements, that would be due to each category of improvements. As illustrated in table 1-6, this imformation permitted an approximation of the importance of each category. We say "approximation" because here, and throughout the study, we recognized that improvements frequently come in packages that are difficult to subdivide for analysis. For example, plant control and seeding might be useless if no water is available. For this reason we urge caution in interpreting the results too closely. Rather, our analysis indicates potential for further study if specific areas or improvements are involved. In some cases no additional AUM are produced by additional investments because these investments are needed to maintain present levels of capacity. The "miscellaneous structural" category for the Panhandle National Forest is an example of this situation.

At this point, we have developed the following information by National Forest by category of improvement:

--the current total cost of proposed improvements
--the total increase in grazing capacity.

After one more calculation, we can estimate the cost of increasing grazing capacity per AUM.

All of our grazing capacity information is on an annual basis, but our cost information is in terms of total cost per unit of improvement. Most improvements have a useful life span of a number of years. To put cost information on an annual basis, then, we must amortize costs over the estimates of useful life found in appendix A. The results of these calculations, and estimates of the cost per added AUM of proposed improvements are presented in table 1-6.

If all the requested investments were made on the Planning Area, the grazing capacity on the National Forests could be increased annually by more than 20,000 AUM. The amortized annual cost would be about $15.00 with the most heavily used Nezperce having the lowest costs by far. Structural improvements promise much lower costs per unit output. For the Planning Area, over 60 percent of the increase in grazing capacity is promised by about 10 percent of the total projected expenditures. But it should be recognized that some of those investments require nonstructural investments, particularly fertilization and plant control, in order to be effective.

Table 1-6.--Calculation of amortized costs of additional AUM by type of improvement in Planning Area 1

Type of improvement	(1) Life span 1/	Clearwater National Forest (2) Total projected costs 2/	(3) Annual amortized costs 3/	(4) Additional AUM 4/	Annual amortized cost per additional AUM 5/	Panhandle National Forest Total projected costs	Annual amortized costs	Additional AUM	Annual amortized cost per additional AUM
	Years	Dollars		AUM		Dollars		AUM	Dollars
A Access	40	79,491	8,129	259	31.4	24,750	2531	55	46.D
8 Rain tanks	30								
C Spring tanks	30	11,000	1,167	184	6.3				
F Dam & reservoir	30	15,600	1,655	184	9.0				
G Other water develop.	30	3,454	366	117	3.1				
H Fences	25	109,053	12,014	633	19.0	42,548	4,687	350	13.4
I Miscellaneous	10	15,822	2,575	19	135.5	3D,303	4,932	0	6/
STRUCTURAL Subtotal	--	234,420	25,906	1,396	18.6	97,601	12,150	4D5	30.0
J Ground preparation	5	1,60D	422	22	19.2				
K Seeding	30	32,285	3,425	370	9.3				
L Fertilization	3	15D,797	6D,636	807	75.1				
N Plant control	15	123,130	16,188	266	60.9	63,350	8,329	444	18.8
O Rodent control	5	3,160	834	6	138.9				
P Miscellaneous	1	44,3D3	48,733	196	248.6	9,642	10,606	63	168.4
NONSTRUCTURAL Subtotal	--	355,275	130,238	1,667	78.1	72,992	18,935	507	37.4
GRAND TOTAL	--	589,695	156,144	3,063	51.0	170,593	31,085	912	34.1

1/ Appendix Table A-6.
2/ Table 1-5.
3/ Column 2 multiplied by 10% interest factor from Appendix Table A-6.
4/ Expanded sample data from Appendix A-1.
5/ Column 3 divided by Column 4.
6/ Infinite

Table 1-6.--Continued

Type of investment	Life-span	Nezperce National Forest Total projected costs	Annual amortized costs	Additional AUM	Annual amortized cost per additional AUM	Planning Area 1 Total projected costs	Annual amortized costs	Additional AUM	Annual amortized cost per additional AUM
	Years	Dollars		AUM		Dollars		AUM	Dollars
A Access	40	167,39D	17,117	1,660	10.3	271,631	27,777	1,974	14.1
8 Rain tanks	30								
C Spring tanks	30	17,208	1,825	4,099	0.4	28,208	2,992	4,283	0.7
F Dam & reservoir	30	800	85	379	0.2	16,400	1,740	563	3.1
G Other water develop.	30					3,454	366	117	3.1
H Fences	25	194,927	21,475	3,122	6.9	346,528	38,176	4,105	9.3
I Miscellaneous	10					46,125	7,507	19	395.1
STRUCTURAL Subtotal		380,325	40,5D2	9,26D	4.4	712,346	78,558	11,061	7.1
J Ground preparation	5					1,60D	422	22	19.2
K Seeding	30	119,775	12,706	3,818	3.3	152,060	16,131	4,188	3.8
L Fertilization	3	102,752	41,317	1,024	40.4	253,549	101,953	1,831	55.7
N Plant control	15	208,480	27,410	2,557	10.7	394,960	51,927	3,267	15.9
O Rodent control	5	1,98D	522	16	32.6	5,140	1,356	22	61.6
P Miscellaneous	1					53,945	59,339	259	229.1
NONSTRUCTURAL Subtotal		432,987	81,955	7,414	11.0	861,254	231,128	9,589	24.1
GRAND TOTAL		81D,9D9	122,457	16,675	7.3	1,573,600	309,686	20,650	15.0

PLANNING AREA 2: WESTERN MONTANA

Planning Area 2 is characterized by rugged mountain peaks and a few broad valleys. It includes four entire National Forests and single Ranger Districts from two others. In 1970, there were 157,000 people and 3,800 ranches and farms, including 268 permittees, in this Indiana-size Area.

While the acreage of this area is about one-third of the total acreage of the Region, grazing is severely limited. The Area has only 13 percent of the Region's grazing acreage and 4 percent of the grazing capacity (table 2-1).

Historical Improvements

Existing range improvements in this Area are summarized in table 2-2. The improvements are mainly for controlling livestock: cattleguards, corrals, and loading chutes. Water is relatively abundant and little investment has been aimed at improving forage productivity.

Table 2-1.--Selected descriptors of Planning Area 2, 1975

Administrative unit	Number of allotments	Number of permittees	Total net acreage	Net grazing acreage		Current grazing capacity
				Total	Percent under timber canopy	
						AUM
Bitterroot N.F.	64	56	1,579,561	176,449	67	11,292
Flathead N.F.	27	27	2,349,876	89,819	75	2,748
Lolo N.F.	108	77	2,737,901	184,863	86	11,775
Kootenai N.F.	53	62	1,870,475	107,237	84	10,755
Philipsburg R.D.	28	33	398,268	74,900	83	9,319
Lincoln R.D.	16	13	327,000	24,703	41	4,949
Planning Area Total	296	268	8,763,081	657,971	77	50,838
Planning Area as percent of Northern Region	15	12	36	13		4

Table 2-2.--Calculation of total and amortized replacement costs of historical improvements in Planning Area 2

Type of improvement	Existing number	Replacement cost: Per unit	Replacement cost: Total	Category replacement cost	Useful life	Amortized replacement cost
		Dollars	Dollars	Dollars	Years	Dollars
A 1 Cattleguard	198	1,297	256,806	291,704	40	29,829
2 Stock trail (mi)	27.5	1,269	34,898			
8 Tanks	1	1,300	1,300	1,300	30	138
C Spring, tanks	198	497	98,406	98,406	30	10,439
D Wells	1	1,167	1,167	1,167	30	124
E Water transmission (mi)	1.4	4,866	6,812	6,812	30	723
F Dam & Reservoir	11	333	3,663	3,663	30	388
G Other water development	8	10	80	80	30	8
H Fence (mi)	471.0	2,335	1,099,785	1,099,785	25	121,162
I Cabin	1	5,000	5,000			
Corral	21	1,000	21,000	27,500	10	4,475
Loading chute	3	500	1,500			
Structural Subtotal			1,530,417			167,286
K Seeding (ac)	4,694	12	56,328	56,328	30	5,975
L Fertilizer (ac)	7	4	28	28	3	11
M Water retention (ac)	104	10	1,040	1,040	30	110
N Plant control (ac)	670	7	4,690	4,690	15	617
O Rodent control (ac)	120	1	120	120	5	32
Nonstructural Subtotal			62,206			6,745
GRAND TOTAL			1,592,623			174,031

Replacement Costs and Productivity

The replacement costs of the historical improvements are presented in table 2-2. At today's costs, they represent an investment of $1,590,000. This is nearly 7 percent of the replacement costs of all improvements in the Region.

The last column in the table lists the equivalent annual investments that would be required to maintain the historical level of improvements. In total this would amount to about $174,000 per year. We can now calculate a rough index of the productivity of these improvements:

Grazing capacity	50,838 AUM
Total amortized cost of improvements	$174,031.00
Cost per AUM	$ 3.42

Past Expenditures

Past expenditures in the Planning Area were estimated to be 7 percent of the Region's total investment program for developing grazing resources on National Forests (table 2-3). This $700,000 cumulative investment supports 4 percent of the Region's total grazing capacity. About one-third of the funds came from Forest Service range improvement, other Forest Service, and permittee accounts respectively.

Table 2-3.--Historical expenditures for improvements in Planning Area 2 in total and a percent of total expenditures in the Northern Region by sources of funds

Source of funds	Expenditures	
	Dollars	As percent of expenditures in Region
Forest Service range improvements	248,400	6
Other Forest Service	224,300	9
Permittees	229,600	7
ALL	702,300	7

Proposed Improvements

The 24 Ranger Districts in Planning Area 2 provided sample data for 38 allotments. The proposed improvements are presented by administrative unit for the sampled allotments in appendix table A-2; projections to total estimates for those units are given in table 2-4.

In total, the estimated improvements would cost $2.3 million. The most critical improvements would be in fencing of all types; access structures are the other main item. Investments for water developments would continue to be relatively modest. The control of unwanted vegetation is the most important kind of ground treatment that is proposed.

As was found for every Planning Area, the proposed improvements, while still heavily weighted towards structures, reflect an increased concern for direct ground treatments:

	Replacement costs of existing improvements (percent)	*Costs of proposed improvements (percent)*
Structural	96	79
Nonstructural	4	21

Productivity of Proposed Improvements

Given the total investment costs of the proposed improvements, we can calculate the annual-equivalent or amortized cost of these improvements (table 2-5). From our sample data, we are able to approximate the added capacity that would result to each category of improvement and, finally, to approximate the cost per additional AUM of capacity (table 2-6).

The Bitterroot National Forest--which had the largest investments--also had the highest average cost for increasing capacity; the Philipsburg Ranger District had the lowest cost. Overall, it would cost $16 on the average to increase capacity by one AUM in this Planning Area.

Table 2-4.--Total proposed improvements and their costs for Planning Area 2

	Type of improvement	Bitterroot N. F. Units	Bitterroot N. F. Cost	Flathead N.F. Units	Flathead N.F. Cost	Kootenai N. F. Units	Kootenai N. F. Cost	Lolo N. F. Unit	Lolo N. F. Cost	Philipsburg R. D. Units	Philipsburg R. D. Cost	Lincoln R. D. Units	Lincoln R. D. Cost	Planning Area Total costs
			Dollars		Dollars		Dollars		Dollars		Dollars		Dollars	Dollars
A	1 Cattleguard	35	61,688	23	39,100	49	42,962	48	57,853	15	16,200	13	19,500	237,303
	2 Stock trail (mi)	17	17,000			4	160					13	26,000	43,160
	3 Stock bridge					4	60,000							60,000
C	6 Spring, wood tank					4	1,200					40	33,333	34,533
	7 Spring, metal tank	80	21,333			25	11,714	56	22,831	15	12,000	27	20,250	88,128
E	13 Water pipe (mi)	9	11,250					13	4,333			8	39,333	54,916
	14 Water ditch (mi)	4	10,000			4	120,000							130,000
F	15 Dam & reservoir					11	3,667							3,667
G	16 Other water develop							1,299	12,990					12,990
H	17 Fence, boundary (mi)	21.6	43,200					17.3	29,843					73,043
	18 Fence, allot. boundary (mi)	62.8	200,094	14.6	27,594	56.1	118,862	17.3	21,193	7.6	22,800	26.7	66,750	457,293
	19 Fence, interior (mi)	106.1	266,766	20.4	38,556	21.4	46,049	36.8	52,819	30.5	99,125	53.3	119,925	623,240
	20 Fence, water source (mi)	3.2	6,400			0.4	120	1.3	1,300					7,820
	STRUCTURAL Subtotal		637,731		105,250		404,734		203,162		150,125		325,091	1,826,093
J	2 Ground prep., burn (ac)	129.9	7,794					433	4,330					12,124
K	4 Seeding, broadcast, air (ac)	2,445.9	38,420											38,420
	6 Interseeding (ac)	6,494	64,940											64,940
L	7 Fertilize, estab. (ac)	6,494	10,823											10,823
	8 Fertilize, prod. (ac)	2,445.9	22,013			11,931	58,953							80,966
M	9 Water retention (ac)									763	7,630			7,630
N	11 Plant control burning (ac)	21,645	43,290							1,527	31,304			74,594
	12 Plant control, mech. (ac)	1,299	12,990					346	34,600	-		666	17,982	65,572
	13 Plant control, chem. (ac)					316	1,580	1,299	19,485			1,200	40,000	61,065
	14 Plant control, hand (ac)	320	8,000			7	1,400							9,400
O	15 Rodent control (ac)	1,083	758											758
P	16 Miscellaneous	--	46,753			--	3,509	--	9,524					59,786
	NONSTRUCTURAL Subtotal		255,781		0		65,442		67,939		38,934		57,982	486,078
	GRAND TOTAL		893,512		105,250		470,176		271,101		189,059		383,073	2,312,171

Table 2-5.--Amortized costs of proposed improvements in Planning Area 2

Type of improvement	Lifespan in years	Annual amortized cost						
		Bitterroot N.F.	Flathead N.F.	Kootenai N.F.	Lolo N.F.	Philipsburg R.D.	Lincoln R.D.	Planning Area total
		Dollars						
A Access	40	8,046	3,998	10,545	5,916	1,656	4,653	34,815
C Spring tanks	30	2,263		1,370	2,422	1,273	5,684	13,012
E Water transmission	30	2,254		12,730	460		4,172	19,616
F Dam & reservoir	30			389				389
G Other water develop	30				1,378			1,378
H Fence	25	56,898	7,288	18,181	11,585	13,432	20,566	127,949
STRUCTURAL Subtotal		69,461	11,286	43,215	21,760	16,362	35,075	197,159
J Ground preparation	5	2,056			1,142			3,198
K Seeding	30	10,964						10,964
L Fertilizer	3	13,204		23,705				36,909
M Water retention	30					809		809
N Plant control	15	8,451		392	7,111	4,116	7,623	27,693
O Rodent control	5	200						200
P Miscellaneous	1	51,428		3,860	10,476			65,764
NONSTRUCTURAL Subtotal		86,303		27,957	18,729	4,925	7,623	145,537
GRAND TOTAL		155,764	11,286	71,172	40,489	21,287	42,698	342,696

Table 2-6.--Additional grazing capacity and cost per additional AUM of proposed improvements in Planning Area 2

Category of improvement	Total additional AUM						
	Bitterroot N.F.	Flathead N.F.	Kootenai N.F.	Lolo N.F.	Philipsburg R.D.	Lincoln R.D.	Planning Area Total
	AUM's						
A Access	143	3	1,110	108	0	27	1,391
C Spring tanks	312		88	542	419	479	1,840
E Water transmission	221		1,265	225		399	2,110
F Dam & reservoir			327				327
G Other water				0			0
H Fence	1,092	356	2,034	628	6,848	320	11,278
STRUCTURAL Subtotal	1,768	359	4,824	1,503	7,268	1,225	16,946
J Ground preparation	30			0			30
K Seeding	139						139
L Fertilizer	126		1,293				1,419
M Water retention					610		610
N Plant control	559		179	589	534	373	2,234
O Rodent control	0						0
P Miscellaneous	0		0	95			95
NONSTRUCTURAL Subtotal	854		1,472	684	1,144	373	4,527
GRAND TOTAL	2,622	359	6,296	2,188	8,411	1,598	21,473

Category of improvement	Annual Amortized cost per additional AUM						
	Bitterroot N.F.	Flathead N.F.	Kootenai N.F.	Lolo N.F.	Philipsburg R.D.	Lincoln R.D.	Planning Area Total
	Dollars/AUM						
A Access	56.3	1332.7	9.5	54.8	----	172.3	25.0
C Spring tanks	7.2		15.6	4.5	3.0	11.9	7.1
E Water transmission	10.2		10.1	2.0		10.5	9.3
F Dam & reservoir			1.2				1.2
G Other water				----			----
H Fence	52.1	20.5	8.9	18.4	2.0	64.3	11.4
STRUCTURAL Subtotal	39.3	31.4	9.0	14.5	2.2	28.6	11.6
J Ground preparation	68.5			----			106.6
K Seeding	78.9						78.9
L Fertilizer	104.8		18.3				26.0
M Water retention					1.3		1.3
N Plant control	15.1		2.2	12.1	7.7	20.4	12.4
O Rodent control	-----						----
P Miscellaneous	-----		----	110.3			692.2
NONSTRUCTURAL Subtotal	100.8		19.0	27.4	4.3	20.4	32.2
GRAND TOTAL	59.4	31.4	11.3	18.5	2.5	26.7	16.0

PLANNING AREA 3: CENTRAL MONTANA

Planning Area 3 stretches 300 miles into Montana from its eastern border on the Continental Divide and about 400 miles from Wyoming on its southern edge north to Canada. It included a quarter-million people in 1970, the largest population of any Planning Area in the Region. Of the 6,400 ranches and farms in the Area, 11 percent had permits to graze on the four National Forests including the Beaverhead, Deerlodge, Helena, and Lewis and Clark. Selected descriptors of the Area are presented in table 3-1. Because they are physically more similar to the northwestern Montana National Forests, the Philipsburg and Lincoln Ranger Districts of the Deerlodge and Helena National Forests, respectively, are included in Planning Area 2.

More than one-fourth of the Region's grazing occurs in the broad valleys of Planning Area 3. With the exception of the grasslands of Planning Areas 5A and 5B, this Area has the smallest proportion of grazing under timber canopies. The Beaverhead National Forest dominates the Area in terms of grazing capacity and use; on this Forest, 58 percent of the Area's grazing capacity is concentrated on 43 percent the Area's grazing acreage.

Historical Improvements

In the past, the Area has received more than its proportionate share of improvements. A preponderance of the basic improvements required for any grazing--the construction of cattleguards, stock trails, and fencing--are concentrated here. This is also true of those improvements which characterize first-order efforts to improve utilization of forage--water transmisslon, ground preparation, rainwater retention, and plant control. At least in part, this past level of relatively heavy investment was no doubt due to the natural productivity of the land for grazing. This is partly reflected in the presence of the large number of privately financed cabins, barns, corrals, and loading chutes on the Beaverhead.

Table 3-1.--Selected descriptors of Planning Area 3, 1975

National Forest	Number of allotments	Number of permittees	Total net acreage	Net grazing acreage: Total	Net grazing acreage: Percent under timber canopy	Current grazing capacity
						AUM
Beaverhead	199	221	2,132,209	639,110	23	174,349
Lewis and Clark	160	199	1,906,535	350,228	29	51,957
Deerlodge	94	134	787,300	293,829	43	39,119
Helena	78	132	639,313	210,188	67	33,624
Planning Area Total	531	686	5,465,357	1,493,355	35	299,049
Planning Area as percent of Northern Region	28	30	23	30	--	28

Replacement Costs and Productivity

We can generally trace the historical costs of making each of the existing improvements. However, for the purpose of making comparisons with proposals for future improvements, we have developed replacement costs by valuing on-the-ground improvements at today's average Planning Area costs, as determined in our survey. The results of these calculations are shown in table 3-2.

At today's prices, the existing range improvements in the Area represent an investment of almost $10 million. This represents about 43 percent of the replacement value of all investments that have been made in the Region. Since grazing capacity is only slightly more than one-quarter of the Region's total, this again suggests the Planning Area has a relatively highly developed range resource.

Because improvements have average useful lives of up to 40 years, it is necessary to amortize them over their lifespans to determine their average annual costs. The results are presented in the last column of table 3-2.

We can now calculate the productivity of current improvements by comparing annual replacement costs to annual AUM supported:

Grazing capacity	299,049 AUM
Total amortized cost of improvements	$1,131,794.00
Cost per AUM	$ 3.78

Table 3-2.--Calculation of total and amortized replacement costs of historical improvements in Planning Area 3

Type of improvement	Existing number	Replacement cost Per Unit	Replacement cost Total	Category replacement cost	Useful life	Amortized replacement cost
		Dollars	Dollars	Dollars	Years	Dollars
A 1 Cattleguard	501	1,699	851,199			
2 Stock trail (mi)	189.4	1,043	197,544	1,053,993	40	107,780
3 Stock bridge	1	5,250	5,250			
B Tanks	8	1,296	10,368			
C Spring, tanks	1,072	593	635,696	649,943	30	68,946
D Wells	3	1,293	3,879			
E Water transmission (mi)	100.4	2,208	221,683			
F Dam & reservoir	95	1,273	120,935	413,118	30	43,823
G Other water dev.	47	1,500	70,500			
H Fence (mi)	3,155.3	1,879	5,928,809	5,928,809	25	653,168
I Cabin	11	5,000	55,000			
Barn	11	5,000	55,000			
Corral	30	1,000	30,000	145,000	10	23,598
Loading chute	6	500	3,000			
Dipping vats	4	500	2,000			
Structural Subtotal			8,190,863			897,315
J Ground preparation (ac)	522	13	6,786	6,786	5	1,790
K Seeding (ac)	777	10	7,770	7,770	30	824
L Fertilizer (ac)	522	10	5,220	5,220	3	2,099
M Water retention (ac)	2,566	10	25,660	25,660	30	2,722
N Plant control (ac)	172,690	10	1,726,900	1,726,900	15	227,041
O Rodent control (ac)	12	1	12	12	5	3
Nonstructural Subtotal			1,746,688			234,479
GRAND TOTAL			9,937,551			1,131,794

Table 3-3.--Historical expenditures for improvements in Planning Area 3 in total and as percentage of total expenditures in the Northern Region by sources of funds

Source of funds	Expenditures	
	Dollars	As percentage of expenditures in Region
Forest Service range improvements	2,714,000	66
Other Forest Service	1,090,800	43
Permittees	1,796,600	56
ALL	5,601,400	57

Past Expenditures

Past expenditures in the Planning Area amounted to 57 percent of the Region's total investment program in developing grazing resources (table 3-3). This almost $6 million cumulative investment supports only 28 percent of the Region's total grazing capacity.

About one-third of all funds (in a combination of cash and labor) come from the permittees. Forest Service range improvement expenditures accounted for about one-half of the total, while other Forest Service expenditures account for the balance. There were considerable differences between National Forests with the Beaverhead and Deerlodge National Forests containing most of the investments.

Proposed Improvements

The 17 Ranger Districts in this Planning Area provided data for 54 allotments. The large number of allotments sampled reflects an increase in sampling intensity on the Beaverhead National Forest to six allotments per Ranger District. This was done to reflect the greater grazing opportunities on that Forest. The proposed improvements are presented by National Forest for the sampled allotments in appendix table A-3. Multiplying those figures by the appropriate sample expansion factors gives the estimated total investment opportunities in table 3-4.

The total improvements for the Planning Area are estimated to cost about $6 million, with over 60 percent of that money going to the Beaverhead. The largest expenditures are proposed for fencing, plant control, and water developments.

A comparison of the replacement costs of historical improvements to the costs of proposed improvements suggest some change in emphasis:

	Replacement costs of existing improvements (Percent)	*Cost of proposed improvements* (Percent)
Structural	82	72
Nonstructural	18	28

It is likely that, given the past substantial investments in structural improvements which still have long useful lives, more attractive opportunities exist in direct ground treatments.

Table 3-4.--Total proposed improvements and their costs for Planning Area 3

	Type of improvement	Beaverhead N.F.		Lewis & Clark N.F.		Deerlodge N.F. minus Philipsburg R.D.		Helena N.F. minus Lincoln R.D.		Planning Area
		Units	Cost	Units	Cost	Units	Cost	Units	Cost	Total Cost
			Dollars		Dollars		Dollars		Dollars	Dollars
A 1	Cattleguard	103	168,663	29	45,433	33	57,750	28	56,000	327,846
2	Stock trail (mi)	35.2	65,281	9.8	4,900	24.7	12,350	13.8	4,588	87,119
B 4	Trick tank							64	86,857	86,857
5	Pit tank			20	22,000					22,000
C 6	Spring, wood tank	84	81,415	265	137,408			101	64,272	283,095
7	Spring, metal tank	330	195,090	29	13,775	49	24,500	37	18,500	251,865
8	Spring, plastic tank					41	20,500			20,500
O 11	Well, pump	13	9,750	10	20,000					29,750
E 13	Water pipe (mi)	105.1	238,666	39.3	85,969	8.2	12,300			336,935
F 15	Dam & reservoir	13	26,000	20	16,000					42,000
G 16	Other water develop.	6	9,000							9,000
H 17	Fence, boundary (mi)	71.2	174,747	39.3	87,442	32.9	32,077			294,266
18	Fence, allot. boundary (mi)	240.6	461,159	159.6	245,489	8.2	32,800			739,448
19	Fence, interior (mi)	598.3	1,121,916	85.9	174,647	125.4	247,511	116.6	202,903	1,746,977
20	Fence, water source (mi)			11.8	19,175					19,175
I 22	Cabin			-----	22,099					22,099
STRUCTURAL Subtotal			2,551,687		894,337		439,788		433,120	4,318,932
J 1	Ground prep. plow (ac)			2,259	17,688			1,835	36,700	54,388
K 3	Seeding, broadcast, ground (ac)	12,587	38,805							38,805
5	Seeding, normal (ac)			982	9,820			1,835	9,175	18,995
6	Seeding, interseeding (ac)			1,277	11,787					11,787
L 7	Fertilize, estab. (ac)	6,468	213,444					1,835	64,225	277,669
8	Fertilize, prod. (ac)	40,424	168,164	1,277	49,113					217,277
N 11	Plant control, burning (ac)	43,820	184,482	2,946	19,653	822	9,866			214,001
13	Plant control, chem. (ac)	45,469	588,369	7,857	64,427	822	4,111	2,845	142,250	799,157
14	Plant control, hand (ac)	323	16,150							16,150
NONSTRUCTURAL Subtotal			1,209,414		172,488		13,977		252,350	1,648,229
GRAND TOTAL			3,761,101		1,066,825		453,765		685,470	5,967,161

Productivity of Proposed Improvements

Based on sample data we can associate categories of proposed improvements with increases in grazing capacity. Because grazing capacity is an annual figure, the costs of long-lived improvements must be amortized over their useful lives. The results of these calculations are shown in table 3-5.

Finally, we can calculate the annual amortized cost of producing one more AUM. From table 3-6 we see that the average cost per additional AUM for Planning Area 3 would be about $8.00. The cost would be least on the Deerlodge and greatest on the Beaverhead National Forest. One explanation for such differences is the Beaverhead National Forest has already invested in the more productive improvements: only the less productive ones remain.

Table 3-5.--Amortized cost of proposed improvements in Planning Area 3

Type of improvement	Lifespan in years	Annual amortized costs				Planning Area total
		Beaverhead	Lewis & Clark	Deerlodge	Helena	
		Dollars				
A Access	40	23,923	5,147	7,168	6,196	42,434
B Rain tanks	30		2,334		9,214	11,548
C Spring tanks	30	29,331	16,037	4,773	8,780	58,921
D Wells	30	1,034	2,122			3,156
E Water transmission	30	25,318	9,120	1,305		35,743
F Dam and reservoir	30	2,758	1,697			4,455
G Other water develop.	30	955				955
H Fence	25	193,657	58,032	34,415	22,354	308,458
I Miscellaneous	10		3,596			3,596
STRUCTURAL Subtotal		276,976	98,095	47,661	46,544	469,266
J Ground preparation	5		4,666		9,681	14,347
K Seeding	30	4,116	2,292		973	7,381
L Fertilization	3	153,447	19,749		25,825	199,021
N Plant control	15	103,733	11,054	1,838	18,702	135,327
NONSTRUCTURAL Subtotal		261,296	37,761	1,838	55,181	356,076
GRAND TOTAL		538,272	135,856	49,499	101,725	825,342

Table 3-6.--Additional grazing capacity and cost per additional AUM of proposed improvements in Planning Area 3

Type of improvement	Total additional AUM				Planning Area Total	Annual amortized cost per additional AUM				Planning Area Total
	Beaverhead	Lewis & Clark	Deerlodge	Helena		Beaverhead	Lewis & Clark	Deerlodge	Helena	
	AUM					Dollars				
A Access	400	16	1,151	189	1,756	59.8	321.7	6.2	32.8	24.2
B Rain tanks		579		1,522	2,101		4.0		6.0	5.5
C Spring tanks	10,315	13,725	4,341	2,376	30,757	2.8	1.2	1.1	3.7	1.9
D Wells	776	49			825	1.3	43.3			3.8
E Water transmission	7,541	2,977	617		11,135	3.4	3.1	2.1		3.2
F Dam and reservoir	647	314			961	4.3	5.4			4.6
G Other water develop.	0				0	----				----
H Fence	9,206	11,400	9,295	2,687	32,588	21.0	5.1	3.7	8.3	9.5
I Miscellaneous		0			0		----			----
STRUCTURAL Subtotal	28,885	29,060	15,404	6,774	80,123	9.6	3.4	3.1	6.9	5.9
J Ground preparation		210		142	352		22.2		68.2	40.8
K Seeding	385	342		142	869	10.7	6.7		6.8	8.5
L Fertilization	3,366	106		142	3,614	45.6	186.3		181.9	55.1
N Plant control	11,197	3,302	1,879	1,381	17,759	9.3	3.4	1.0	13.5	7.6
NONSTRUCTURAL Subtotal	14,948	3,960	1,879	1,807	22,594	17.5	9.5	1.0	30.5	15.8
GRAND TOTAL	43,833	33,020	17,283	8,581	102,717	12.3	4.1	2.9	11.8	8.0

PLANNING AREA 4: CENTRAL ROCKY MOUNTAINS

Planning Area 4 extends north and northwest from Yellowstone National Park into central Montana. The Area is characterized by rugged and steep forested slopes, extending from the Yellowstone River Valley to the Gallatin River drainage. The highest mountain in Montana, Granite Peak, is included. It is the smallest Planning Area in the Region, containing only the Gallatin National Forest and the Beartooth Ranger District of the Custer National Forest. In 1970, about 60,000 people lived within the Area. There were 2,647 ranches and farms; the 231 holders of permits for National Forest grazing were 10 percent of all permittees in the Region (table 4-1).

Historical Improvements

To develop the current modest grazing capacity in this rugged country, investments were required in providing access, water, fencing, and ground preparation (table 4-2). These kinds of improvements result in about 4 percent of the Region's total grazing capacity.

Replacement Costs and Productivity

At today's costs, these historical improvements would cost almost $750,000 to replace. When amortized over the useful life of the improvements, this cost averages about $84,000 annually. For the Planning Area, we can divide this annual replacement cost by grazing capacity to get a rough index of current productivity.

Grazing capacity	50,343 AUM
Total amortized costs of improvements	$83,853.00
Cost per AUM	$ 1.67

Past Expenditures

Past expenditures on the Gallatin National Forest and Beartooth Ranger District amounted to 5 percent of the Region's total. These are divided among contributors as shown in table 4-3. Almost 65 percent of these funds come from the Forest Service range improvement accounts with most of the rest coming from permittees.

Proposed Improvements

The seven Ranger Districts in this Area provided sample data for 13 allotments. The investment opportunities they propose are listed in appendix table A-4. These opportunities were projected for the entire Planning Area by using the sample expansion factors based on the ratio of sampled to total grazing capacities. The total physical improvements and their costs are displayed in table 4-4. The estimates total about $920,000 for the Gallatin National Forest and $46,000 for the Beartooth Ranger District. Such a package of investments will increase grazing capacities by almost 12,000 AUM, that is, by one-fourth.

Table 4-1.--Selected descriptors of Planning Area 4, 1975

Administrative unit	Number of allotments	Number of permittees	Total net acreage	Net grazing acreage: Total	Net grazing acreage: Percent under timber canopy	Current grazing capacity
						AUM
Gallatin N.F.	170	199	1,369,119	297,056	47	35,836
Beartooth R.D.	28	32	586,573	45,610	27	14,507
Planning Area Total	198	231	1,955,692	342,666	44	50,343
Planning Area as percent of Northern Region	10	10	8	7	--	4

Table 4-2.--Calculation of total and amortized replacement costs of historical improvements in Planning Area 4

Type of improvement	Existing number	Replacement cost: Per unit	Replacement cost: Total	Category replacement cost	Useful life	Amortized replacement cost
		- - - - Dollars - - - -		Dollars	Years	Dollars
A 1 Cattleguard	14	1,112	15,568			
2 Stock trail (mi)	32.2	1,154	37,159	63,227	40	6,466
3 Stock bridge	2	5,250	10,500			
C Spring, tanks	155	398	61,690	61,690	30	6,544
E Water transmission (mi)	5.3	433	2,295	2,295	30	243
H Fence (mi)	319.8	1,713	547,817	547,817	25	60,352
I Cabin	2	5,000	10,000			
Barn	1	5,000	5,000	16,000	10	2,604
Corral	1	1,000	1,000			
Structural Subtotal			691,029			76,209
J Ground preparation (ac)	404	13	5,252	5,252	5	1,385
K Seeding (ac)	459	10	4,590	4,590	30	487
N Plant control (ac)	4,878	9	43,902	43,902	15	5,772
Nonstructural Subtotal			53,744			7,644
GRAND TOTAL			744,773			83,853

Table 4-3.--Historical expenditures for improvements in Planning Area 4 in total and as percent of total expenditures in the Northern Region by sources of funds

Source of funds	Expenditures: Dollars	Expenditures: As percent of expenditures in Region
Forest Service range improvement	287,800	7
Other Forest Service	8,000	Trace
Permittees	154,400	5
All	450,200	5

Table 4-4.--Total proposed improvements and their costs for Planning Area 4

Type of improvement	Gallatin N.F. Units	Gallatin N.F. Cost	Beartooth R.O. Units	Beartooth R.O. Cost	Planning Total Area Cost
		Dollars		Dollars	Dollars
A 1 Cattleguard	20	21,000	14	16,800	37,800
B 5 Pit tank	10	3,000			3,000
C 6 Spring, wood tank	30	12,000	21	10,500	22,500
7 Spring, metal tank	109	44,090			44,090
8 Spring, plastic tank	20	5,000			5,000
E 13 Water pipe (mi)	29.8	12,913			12,913
G 16 Other water develop.			7	700	700
H 18 Fence, allot. boundary (mi)	37.3	57,691			57,691
19 Fence, interior (mi)	293.1	520,625	17.7	17,700	538,325
20 Fence, water source (mi)	.5	1,000			1,000
STRUCTURAL Subtotal		677,319		45,700	723,019
K 4 Seeding broadcast, air (ac)	4,471	44,710			44,710
L 8 Fertilize, prod. (ac)	4,719	32,278			32,278
N 11 Plant control, burn (ac)	1,987	9,935			9,935
13 Plant control, chem. (ac)	14,406	134,120			134,120
14 Plant control, hand (ac)	994	19,880			19,880
P Miscellaneous					
NONSTRUCTURAL Subtotal		240,923			240,923
GRAND TOTAL		918,242		45,700	963,942

In Planning Area 4, a shift in emphasis between historical and proposed investments is apparent:

	Replacement costs of existing improvements (Percent)	*Cost of proposed improvements* (Percent)
Structural	93	73
Nonstructural	7	27

A much larger share of future expenditures will be for direct ground treatments. The Beartooth Ranger District continues to concentrate almost exclusively on structural improvements.

Productivity of Proposed Improvements

When the costs are amortized over the useful lives of the improvements, we find that this package of investments is roughly equivalent to an annual investment of $111,800. The underlying calculations are given in table 4-5.

As expected, the costs per AUM of nonstructural improvements as shown in table 4-6 are substantially higher than those of structures. Overall, production costs would be far lower on the Beartooth Ranger District than on the Gallatin. We hypothesize that this is probably due to a much less intensive development of grazing resources on the Beartooth: there is still a lot of undeveloped grazing capacity and water awaiting the construction of basic fences and access facilities. The average amortized cost per AUM for the Area is $9.60.

Table 4-5.--Amortized cost of proposed improvements in Planning Area 4

Type of improvement	Lifespan in years	Annual amortized cost		
		Gallatin N.F.	Beartooth R.D.	Planning Area Total
		Dollars		
A Access	40	2,147	1,718	3,865
B Rain tank	30	318		318
C Spring tanks	30	6,480	1,114	7,594
E Water transmission	30	1,370		1,370
G Other water	30		74	74
H Fence	25	57,356	1,950	59,306
STRUCTURAL Subtotal		67,671	4,856	72,527
K Seeding	30	4,743		4,743
L Fertilization	3	12,979		12,979
N Plant control	15	21,553		21,553
NONSTRUCTURAL Subtotal		39,275		39,275
GRAND TOTAL		106,946	4,856	111,802

Table 4-6.--Additional grazing capacity and cost per additional AUM of proposed improvement in Planning Area 4

Type of improvement	Total additional AUM			Annual amortized cost per additional AUM		
	Gallatin N.F.	Beartooth R.D.	Planning Area Total	Gallatin N.F.	Beartooth R.D.	Planning Area Total
	AUM			Dollars/AUM		
A Access	0	191	191	--	9.0	20.2
B Rain tank	79		79	4.0		4.0
C Spring tanks	1,977	375	2,352	3.3	3.0	3.2
E Water transmission	199		199	6.9		6.9
G Other water		35	35		2.1	2.1
H Fence	5,653	764	6,417	10.2	2.6	9.2
STRUCTURAL Subtotal	7,908	1,365	9,273	8.6	3.6	7.8
K Seeding	646		646	7.3		7.3
L Fertilization	894		894	14.5		14.5
N Plant control	825		825	26.1		26.1
NONSTRUCTURAL Subtotal	2,365		2,365	16.6		16.6
GRAND TOTAL	10,273	1,365	11,638	10.4	3.6	9.6

PLANNING AREAS 5A AND 5B: EASTERN MONTANA AND THE DAKOTAS

Planning Areas 5A and 5B are both administered by the Custer National Forest (the Beartooth Ranger District of the Custer is included in Planning Area 4). The Areas are administered separately because they are spread over a very large area; 5A includes the high plains of eastern Montana, and 5B the plains of the Dakotas. Area 5B includes the Cheyenne, Cedar River, and Little Missouri National Grasslands in North Dakota and the Grand River National Grasslands in South Dakota.

In 1970 there were about 135,200 people and 3,900 farms and ranches in Area 5A; there were half as many people in Area 5B, but 6,500 farms and ranches. That this is ranching country is again emphasized in the statistics in table 5-1. Together, the Planning Areas have 60 percent of the Region's grazing capacity on one-third of the Region's grazing acreage and only 7 percent of the total National Forest acreage. The key is simply the openness of the range; there is little timber. As a consequence, while on the average in the Region more than 4 acres are required to support one AUM, in areas 5A and 5B only 3 and 2 acres per AUM are required, respectively.

Table 5-1.--Selected descriptors of Planning Areas 5A and 5B, 1975

Ranger District	Number of allotments	Number of permittees	Total net acreage	Net grazing acreage		Current grazing capacity
				Total	Percent under timber canopy	
						AUM
Ashland	27	41	207,507	156,066	36	58,300
Fort Howes	25	36	230,231	230,151	16	56,045
Sioux	64	84	162,889	120,519	35	50,200
Planning Area 5A Total	116	161	600,627	506,736	27	164,545
Planning Area as percent of Northern Region	6	7	2	10	--	14
Grand River	77	131	161,927	154,649	0	63,903
Medora	266	262	524,452	523,282	0	222,945
McKenzie	206	194	501,000	375,900	3	206,130
Sheyenne	59	99	70,340	69,507	Trace	64,442
Planning Area 5B Total	608	686	1,257,719	1,123,338	1	557,420
Planning Area as percent of Northern Region	32	30	5	22	--	47

Table 5-2.--Calculation of total and amortized replacement costs of historical improvements in Planning Areas 5A and 5B

Type of improvement	Planning Area 5A					Planning Area 5B				
	Existing number	Replacement cost		Useful life	Amortized replacement cost	Existing number	Replacement cost		Useful life	Amortized replacement cost
		Per unit	Total				Per unit	Total		
		Dollars		Years	Dollars		Dollars		Years	Dollars
A Cattleguard	68	1,275	86,700	40	8,866	22	1,490	32,780	40	3,352
B Tanks	49	809	39,641			371	809	300,139		
C Spring, tanks	531	504	267,624	30	147,952	101	1,066	107,666	30	348,889
D Wells	110	9,886	1,087,460			347	8,303	2,881,141		
E Water transmission (mi)	10.0	3,099	30,990			17.1	4,640	79,344		
F Dam & Reservoir	337	1,500	505,500	30	57,077	505	1,180	595,900	30	74,061
G Other water develop.	10	157	1,570			146	157	22,922		
H Fence (mi)	946.5	1,870	1,769,955	30	187,756	1,235.4	1,875	2,316,375	30	245,720
I Corral	6	1,000	6,000	10	976	79	1,000	79,000	10	12,857
Structural Subtotal			3,795,440		402,627			6,415,267		684,879
J Ground prep (ac)										
K Seeding (ac)	727	2	1,454	30	154	891	2	1,782	30	189
L Fertilizer (ac)	127	9	1,143	3	460	470	4	1,880	3	756
N Plant control (ac)						40	12	480	25	53
Nonstructural Subtotal			2,597		614			4,142		998
GRAND TOTAL			3,798,037		403,241			6,419,409		685,877

Historical Improvements

Although grazing can take place on unimproved open range, some improvements are necessary for administrative control, to protect the range resource, and to increase grazing capacity. On the Custer National Forest minus the Beartooth Ranger District, as shown in table 5-2, most attention has been focused on developing water sources and fences. Most of the entire Region's water development investments have occurred here. In conjunction with this water development, fertilization and seeding have been important to increase forage production, and corrals have been built by the permittees to facilitate herd management.

Replacement Costs and Productivity

By applying current costs of construction and treatment to the historical improvements, we derived the replacement costs of those improvements in table 5-2. They total about $10 million with structures alone, particularly water developments and fencing, nearly accounting for the total. By amortizing these costs over the useful lives of the improvements, we learn that their average annual cost is over $1 million.

We can now calculate the productivity of these improvements by comparing their annual amortized costs to the (annual) AUM they support:

	Area 5A	*Area 5B*
Grazing capacity	164,545 AUM	557,420 AUM
Total amortized cost of improvements	$403,241.00	$685,877.00
Cost per AUM	$ 2.45	$ 1.23

These very low costs per AUM reflect the natural productivity of the Custer National Forest. The low costs in Area 5B may reflect failure to completely account for all range improvement practices on the Natural Grasslands prior to the Forest Service administration.

Past Expenditures

Expenditures related to range management on the Custer National Forest (excluding Beartooth Ranger District) over the years have totaled nearly $2.2 million (table 5-3).

Table 5-3.--Historical expenditures for improvements in Planning Areas 5A and 5B in total and as percent of total expenditures in the Northern Region by sources of funds

Source of funds	Expenditures	
	Dollars	As percent of expenditures in Region
		Percent
Forest Service range improvement	735,600	18
Other Forest Service	568,500	23
Permittees	865,200	27
ALL	2,169,300	15

Only on the Beaverhead National Forest has more money been spent. But because of less productive range there, the Custer has produced many more AUM per dollar spent. Permittees have contributed a substantial share of the improvements.

Proposed Improvements

A more intensive sample was made in Planning Areas 5A and 5B to reflect their greater share of the Region's grazing capacity. Proposed improvements are summarized for the 62 sampled allotments by each of the two Planning Areas in appendix table A-5. Multiplying these sample figures by the appropriate expansion factors gives the estimated total investment opportunities presented in table 5-4. About $12.6 million has been suggested for the two Areas combined.

Table 5-4.--Total proposed improvements and their costs for Planning Areas 5A and 5B

	Type of improvement	Planning Area 5A Units	Planning Area 5A Cost	Planning Area 5B Units	Planning Area 5B Cost
			Dollars		Dollars
A 1	Cattleguard	74	94,350	117	174,330
B 5	Pit tank			64	51,782
C 6	Spring, wood tank	107	100,544	6	6,000
7	Spring, metal tank			35	38,500
8	Spring, plastic tank	228	68,400	12	12,000
D 10	Well, windmill	48	280,615	23	11,500
11	Well, pump	52	707,943	170	1,590,965
E 13	Water pipe (mi)	442.6	1,371,784	1,275.4	5,918,582
F 15	Dam & reservoir	22	33,000	88	103,840
H 17	Fence, boundary (mi)	148.7	289,439		
18	Fence, allot. boundary (mi)	71.8	132,554	23.4	37,440
19	Fence, interior (mi)	175.6	317,350	461.3	871,608
20	Fence, water source (mi)	9.2	18,402		
STRUCTURAL Subtotal			3,414,381		8,816,547
J 1	Ground prep. plow (ac)			11,709	35,127
2	Ground prep. burn (ac)			6,499	6,759
K 5	Seeding, normal (ac)			11,709	23,418
6	Seeding, interseeding (ac)			5,855	11,710
L 7	Fertilize, estab. (ac)			11,709	46,836
8	Fertilize, prod. (ac)	1,840	16,560	22,247	77,197
M 10	Water retention (ac)			11,124	53,284
N 11	Plant control, burn (ac)	9,201	25,855		
13	Plant control, chem. (ac)	736	8,832	2,225	27,812
O 15	Rodent control (ac)			937	2,342
NONSTRUCTURAL Subtotal			51,247		284,485
GRAND TOTAL			3,465,628		9,101,032

As has been true in the past, structures are seen as offering the major investment opportunities on both Planning Areas. There has been some shift toward investments in direct ground treatments:

	Replacement costs of existing improvements (Percent)	*Costs of proposed improvements (Percent)*
Structural	99+	97
Nonstructural	Trace	3

A larger share of Area 5A's proposed expenditures (99 percent) would be used to build structures than in Area 5B (97 percent). As in the past, most attention remains focused on developing water resources and, most particularly, in pipes to spread the available water more evenly over the rangelands. Apparently, practices to improve the productivity of the range are not needed at this time, unlike the rest of the Region. That is, here the limiting factor appears to be water, not forage for most of the two Areas.

Productivity of Proposed Improvements

To estimate productivity of the proposed investments, we need in addition to the costs of those investments the increase in grazing capacity each will produce. Because our estimates of capacity are on an annual basis, we must also put investment costs on an annual basis. The results of these calculations are shown in table 5-5. Dividing the amortized investment costs by increases in capacity (table 5-6) provides the estimated cost per additional AUM.

Table 5-5.--Amortized cost of proposed improvements in Planning Areas 5A and 5B

Type of improvement	Lifespan in years	Annual amortized costs: Planning Area 5A	Annual amortized costs: Planning Area 5B
		Dollars	
A Access	40	9,648	17,827
B Rain tanks	30		5,493
C Spring tanks	30	17,921	5,993
D Wells	30	104,866	169,988
E Water transmission	30	145,518	627,840
F Dam and reservoir	30	3,501	10,015
H Fence	30	80,381	96,431
STRUCTURAL Subtotal		361,835	933,587
J Ground preparation	5		11,049
K Seeding	30		3,726
L Fertilizer	3	6,659	49,874
M Water retention	30		5,652
N Plant control	25	3,821	3,064
O Rodent control	5		618
NONSTRUCTURAL Subtotal		10,480	73,983
GRAND TOTAL		372,315	1,007,570

Table 5-6.--Additional grazing capacity and cost per additional AUM of proposed improvements in Planning Areas 5A and 5B

Type of improvements	Total additional AUM		Annual amortized cost per additional AUM	
	Planning Area 5A	Planning Area 5B	Planning Area 5A	Planning Area 5B
	AUM		Dollars/AUM	
A Access	37	0	260.8	--
B Rain tanks		4,174		1.3
C Spring tanks	1,583	3,519	11.3	1.7
D Wells	9,010	13,864	11.6	12.3
E Water transmission	14,796	83,867	9.8	7.5
F Dam and reservoir	1,564	6,364	2.2	1.7
H Fence	13,728	37,019	5.9	2.6
STRUCTURAL Subtotal	40,718	148,807	8.9	6.3
J Ground preparation		4,918		2.2
K Seeding		2,681		1.4
L Fertilizer	328	7,716	20.3	6.5
M Water retention		1,674		3.4
N Plant control	1,115	140	3.4	21.9
O Rodent control		0		--
NONSTRUCTURAL Subtotal	1,443	17,129	7.3	4.3
GRAND TOTAL	42,161	165,936	8.8	6.1

Contrary to other Planning Areas, the costs of increasing capacity through ground treatments is lower than through building structures. It is worth reemphasizing, though, that some combination of both kinds of improvements is more productive than just financing one kind, once the intensity of management has gone beyond just using nature's bounty. The total costs per AUM on these Planning Units are $8.8 per AUM on Area 5A, and $6.1 per AUM on Area 5B.

SUMMARY FOR NORTHERN REGION

For the entire Northern Region, opportunities now exist to invest $23,320,000 in increasing the annual grazing capacity on the National Forests by more than 360,000 AUM. Historical investments in ground (nonstructural) treatments and in structures now existing are estimated to cost $23,250,000 at today's prices. The current annual grazing capacity is about 1,175,000 AUM.

Proposed and Historical Improvements

Because we have valued all physical improvements at current prices, it is possible to compare those improvements in terms of investment costs. The costs of all improvements by category and Planning Area are summarized in tables S-1 and S-2.

Structural Improvements

Although the total proposed and historical costs of structural improvements are roughly the same, significant differences in the elements of these totals can be seen by examining individual categories of improvements. The last column of table S-1 provides a rough index of shifting priorities. Most notably, far less emphasis is placed on proposed fencing and developing water resources, while expenditures for water transmission would be greatly increased. This is especially apparent on the easternmost Planning Areas, 5A and 5B, which are, essentially, the Custer National Forest. In contrast, fencing would receive a substantially increased share of investment funds on the western, forest-dominated Planning Areas.

Comparing Planning Areas indicates that most Planning Areas would like to increase or at least maintain past investment levels for structural improvements. In contrast, in Planning Area 3, dominated by the Beaverhead National Forest, most structures are apparently already in place and relatively little additional construction has been proposed.

Nonstructural Improvements

The situation is quite different when proposed expenditures for directly increasing forage production are considered. For nearly every category of improvement and for all Planning Areas except one, substantial increases in investment have been proposed (table S-2). Perhaps twice as many acres would be treated in the future as previously, with emphasis on plant control and fertilization in the east and on seeding, fertilization, and plant control in the west. As was true for structural improvements, Planning Area 3 has proposed the lowest level of new investments relative to old investments.

Table S-1.--Current costs of providing historical and proposed structural improvements (top number historical, bottom number proposed), by Planning Area and Region (Dollars)

Category of improvement		Planning Area: N. Idaho 1	W. Montana 2	Cent. Montana 3	Cent. Rocky Mt. 4	E. Montana 5A 1/	Dakotas 5B 1/	Northern Region: Total costs	Proposed as proportion of historical
A. Access	H	168,823	291,704	1,053,993	63,227	86,700	32,780	1,697,227	0.8
	P	271,631	340,463	414,965	37,800	94,350	174,330	1,333,539	
B. Rain tanks	H	7,800	1,300	10,368	0	39,641	300,139	359,248	0.5
	P	0	0	108,857	3,000	0	51,782	163,639	
C. Spring development	H	104,976	98,406	635,696	61,690	267,624	107,666	1,276,058	0.8
	P	28,208	122,661	555,460	71,590	168,944	56,500	1,003,363	
D. Wells	H	0	1,167	3,879	0	1,087,460	2,881,141	3,973,647	0.7
	P	0	0	29,750	0	988,558	1,602,465	2,620,773	
E. Water transmission	H	3,571	6,812	221,683	2,295	30,990	79,344	344,695	22.7
	P	0	184,916	336,935	12,913	1,371,784	5,918,582	7,825,130	
F. Dams and reservoirs	H	27,020	3,663	120,935	0	505,500	595,900	1,253,018	0.2
	P	16,400	3,667	42,000	0	33,000	103,840	198,907	
G. Other water developments	H	314	80	70,500	0	1,570	22,922	95,386	0.3
	P	3,454	12,990	9,000	700	0	0	26,144	
H. Fence	H	203,994	1,099,785	5,928,809	547,817	1,769,955	2,316,375	11,866,735	0.6
	P	346,528	1,161,396	2,799,866	538,325	757,745	909,048	6,512,908	
I. Other structural 2/	H	200,500	27,500	145,000	16,000	6,000	79,000	474,000	0.1
	P	46,125	0	22,099	0	0	0	68,224	
Total structural costs	H	716,998	1,530,417	8,190,863	691,029	3,795,440	6,415,267	21,340,014	
	P	712,346	1,826,093	4,318,932	664,328	3,414,381	8,816,547	19,752,627	
Proposed as proportion of historical		1.0	1.2	0.5	1.0	0.9	1.4	0.9	

1/ Combined 5A and 5B make up Custer National Forest historical improvements excluding Beartooth Ranger District from Planning Area 4.
2/ Historical improvements consist of cabins, barns, corrals, and loading chutes, all totally privately financed. Few such new structures are proposed; most proposals are for miscellaneous structural improvements not specifically identified elsewhere.

Table S-2.--Current costs of providing historical and proposed nonstructural improvements (top number historical, bottom number proposed), by Planning Area and Region (Dollars)

Category of improvement		Planning Area						Northern Region	
		N. Idaho 1	W. Montana 2	Cent. Montana 3	Cent. Rocky Mt. 4	E. Montana 5A 1/	Dakotas 5B 1/	Total costs	Proposed as proportion of historical
J. Ground preparation	H	2,500	0	6,786	5,252	0	0	14,538	7.6
	P	1,600	12,124	54,388	0	0	41,886	109,998	
K. Seeding	H	3,120	56,328	7,770	4,590	1,454	1,782	75,044	5.4
	P	152,060	103,360	69,587	44,710	0	35,128	404,845	
L. Fertilization	H	529	28	5,220	0	1,143	1,880	8,880	115.1
	P	253,549	91,789	494,946	32,278	16,560	124,033	1,013,155	
M. Water retention	H	0	1,040	25,660	0	0	0	26,700	2.3
	P	0	7,630	0	0	0	53,284	60,914	
N. Plant control	H	12,011	4,690	1,726,900	43,902	0	480	1,787,983	1.0
	P	394,960	210,631	1,029,308	163,935	34,687	27,812	1,861,333	
O. Rodent control	H	0	120	12	0	0	0	132	62.4
	P	5,140	758	0	0	0	2,342	8,240	
P. Miscellaneous nonstructural	H	0	0	0	0	0	0	0	---
	P	53,945	59,786	0	700	0	0	114,431	
Total nonstructural	H	18,160	62,206	1,772,348	53,744	2,597	4,142	1,913,197	
	P	861,254	486,078	1,648,229	241,623	51,247	284,485	3,572,916	
Proposed as proportion of historical		47.4	7.8	0.9	4.5	19.7	68.7	1.9	

1/ See footnote on table S-1.

Relative Productivity of Improvements

When nonstructural and structural improvements are combined, the kinds of differences between historical and proposed improvements noted above again can be seen (table S-3) Most historical and proposed improvements are associated with Planning Areas 3, 5A, and 5B, essentially the Beaverhead and Custer National Forests. The Beaverhead is unique, for while its proportion of total proposed expenditures would be less than its proportion of historical expenditures, its share of total added capacity would be greater than its share of current capacity. The explanation is that past expenditures have been far more intensive relative to grazing capacity than anywhere else in the Region. Given those improvements, relatively small further investments would be quite productive.

It is apparent that Planning Areas 1, 2, and 4 contribute relatively little to Regionwide grazing capacity. As a reflection of relatively modest natural productivity and past investments and short seasons when grazing is possible, the proposed substantial increases in expenditures would not contribute proportionally to the expected total increase in the Region's grazing capacity.

Just looking at the total costs of improvements can be misleading because these totals are dominated by expenditures for structures which have long, useful lives. When the costs of long-lived improvements are appropriately amortized, we can determine the average cost of producing one AUM, as summarized in table S-4.

A comparison of the last two columns shows that the average cost per AUM in the past has been less than the average cost per AUM for the proposed capacity increase. This is to be expected, for, to this point, reliance has been much greater on nature's bounty; to a large extent, undeveloped grass and water resources have determined capacity. Increasing that capacity requires a capital-intensive program of development which is more expensive per AUM produced.

With two exceptions, the additional cost of adding one AUM decreases from west to east within the Region. This reflects the natural productivity and forest cover of the land. Planning Area 3 does not fit because of exceptionally high levels of investment in the past, as mentioned earlier.

Table S-3.--Distribution of current and proposed grazing capacities and proportion of current costs for historical and proposed range improvements by Planning Areas

Planning Area	Historical			Proposed		
	Current capacity	Percent of current capacity	Percent of costs of improvements	Additional capacity	Percent of additional capacity	Percent of costs of improvements
	AUM	Percent	Percent	AUM	Percent	Percent
1	52,767	4.5	3.2	20,650	5.7	6.7
2	50,838	4.3	6.8	21,473	5.9	9.9
3	299,049	25.4	42.8	102,717	28.2	25.6
4	50,343	4.3	3.2	11,638	3.2	3.9
5A	164,545	14.0	16.3	42,161	11.6	14.9
5B	557,420	47.5	27.6	165,936	45.5	39.0
Northern Region	1,174,962	100.0	100.0	364,575	100.0	100.0

Table S-4.--Additional amortized cost of structural and nonstructural improvements per additional AUM and average amortized proposed and replacement cost per AUM by Planning Area (Dollars)

Planning Area	Additional Cost per AUM: Proposed improvements: Structural improvements	Nonstructural improvements	Total	Average Cost per AUM: Historical improvements: Total	Proposed improvements: Total
1	7.1	24.1	15.0	1.7	5.4
2	11.6	32.2	16.0	3.4	7.2
3	5.9	15.8	8.0	3.8	4.9
4	7.8	16.6	9.6	1.7	3.2
5A	8.9	7.3	8.8	2.4	3.8
5B	6.3	4.3	6.1	1.2	2.3
Northern Region	6.9	14.9	8.1	2.2	3.6

An Economic Supply Curve

Based on the information presented above by Planning Area, we can now develop approximate relationships between additional grazing capacities that might be produced in the Region and additional costs.

If we assume that the least-cost Planning Area will be entirely funded as a unit before the next Area is funded, the relationship would be as in table S-5.

Because local considerations rule out the chance that Planning Areas would, in fact, be entirely funded one at a time, this approach is not satisfactory. Such a level of aggregation also hides the variation in the productivity of particular kinds of investments within Planning Areas.

An approach more demanding of information is to establish the relationships between additional grazing capacity and specific kinds of investments and their costs, regardless of the administrative unit in which they would occur. This is the approach taken in table S-6.

We do not feel it would be useful at this point to further analyze our data in an attempt to provide a guide for specific investment decisions, though such a guide is sorely needed. Our information simply is not good enough. However, the data in table S-6 do strongly suggest the categories of investments, by Planning Areas, that most demand further investigation.

An approximation of a standard economic supply curve for the Region is shown in figure 2. Based on table S-6, this curve summarizes the costs of increasing grazing capacity by successive increments. It suggests, for example, that if the value of an

Table S-5.--Relationships between additional grazing capacity and costs, assuming Planning Areas are funded as units

Planning Area	Amortized cost per additional AUM	Increase in grazing capacity	Total additional grazing capacity	Total amortized cost of additional grazing capacity
	Dollars	AUM	AUM	Dollars
5B	6.1	165,936	165,936	1,007,570
3	8.0	102,717	268,653	1,832,912
5A	8.8	42,161	310,814	2,205,227
4	9.6	11,638	322,452	2,317,029
1	15.0	20,650	343,102	2,626,715
2	16.0	21,473	364,575	2,969,411

Table S-6.--Relationships between additional grazing capacity and costs, assuming categories of improvements within Planning Areas are funded as units

Planning area	Improvement Category	Amortized cost per additional AUM	Increase in grazing capacity	Total additional grazing capacity	Current cost of additional grazing capacity	Total current cost of additional grazing capacity
		Dollars	AUM	AUM	Dollars	Dollars
5B	Nonstructural	4.3	17,129	17,129	284,485	284,485
3	Structural	5.9	80,123	97,252	4,318,932	4,603,417
5B	Structural	6.3	148,807	246,059	8,816,547	13,419,964
1	Structural	7.1	11,061	257,120	712,346	14,132,310
5A	Nonstructural	7.3	1,443	258,563	51,247	14,183,557
4	Structural	7.8	9,273	267,836	664,328	14,847,885
5A	Structural	8.9	40,718	308,554	3,414,381	18,262,266
2	Structural	11.6	16,946	325,500	1,826,093	20,088,359
3	Nonstructural	15.8	22,594	348,094	1,648,229	21,736,588
4	Nonstructural	16.6	2,365	350,459	241,623	21,978,211
1	Nonstructural	24.1	9,589	360,048	861,254	22,839,465
2	Nonstructural	32.2	4,527	364,575	486,078	23,325,543

AUM produced on National Forests in the Region is in the neighborhood of $4.00,[4] no expansion of grazing capacity would be warranted. On the other hand, if an AUM were valued at $14.60,[5] then about 325,500 AUM more could be efficiently produced. Supply curves for specific Planning Areas, which could better consider local conditions, were not constructed because of the reservations expressed above about the basic study data.

It is likely that the supply curve shown in figure 2 is slightly low, that is, actual costs for given additional grazing capacities in reality would be somewhat higher. The costs derived in this study omit the Forest Service costs for general management and administration.

[4] Based on private lease rates adjusted to reflect differences in operating and harvesting costs as calculated by Sassaman and Fight (1975, p. 187).

[5] Based on market value of beef minus costs from the hoof to the market as calculated by USDA Forest Service (1976, p. BBB-5).

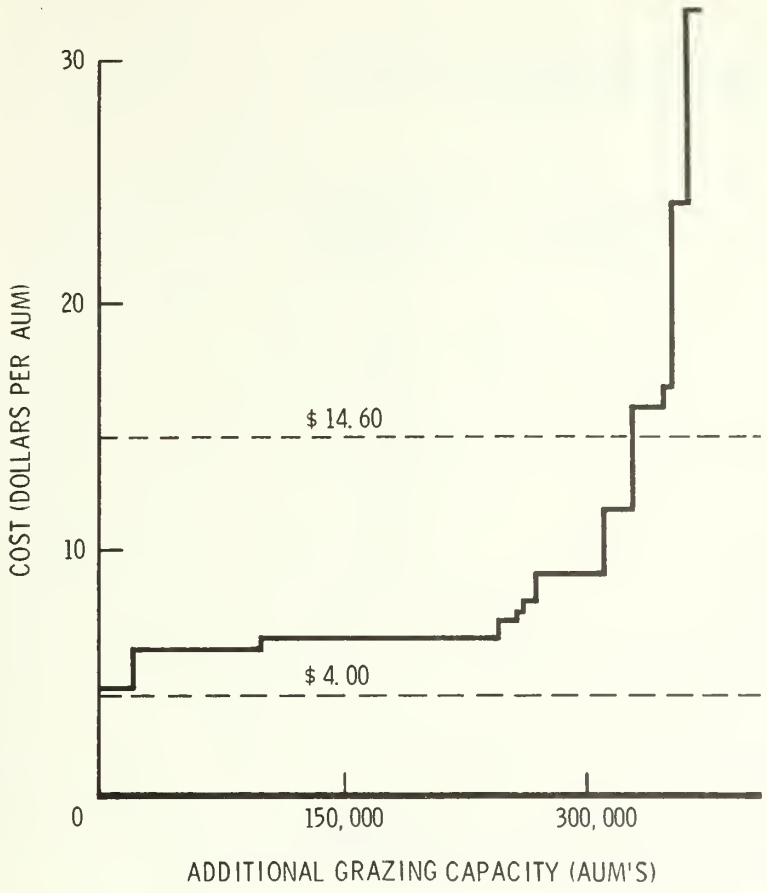

Figure 2.--Economic supply curve for grazing in the Northern Region.

Public Versus Private Funding

Aside from information concerning the values and development costs associated with potential improvements, at least one other issue is critical in determining the desirable level and composition of investments in range improvements on the National Forests. This is the source of investment funds, for some would come from Forest Service appropriations and some from the individual permittees.

By administrative directive the Forest Service must evaluate investments in range development at a 10 percent rate of return while the returns required by permittees for investments to be desirable vary a good deal, but are essentially unknown. In the present study, because only those improvements which would be attractive to the permittees were proposed, we assume they would earn a satisfactory return on their investments. If that is the case, and the economic attractiveness of the total investment is of concern, then the economic supply curve given above is useful. If just the perspective of the Forest Service is considered, the "correct" economic supply curve would be somewhat different, depending upon the cost borne by the Forest Service for specific categories of investment in specific Planning Areas.

The Forest Service proportions of historical and proposed expenditures are presented in table S-7. About two-thirds of all range improvement costs in both instances have been paid by the Forest Service. To the extent that the proportions funded by the permittees are expressions of local economic importance, those proportions also provide a crude index of local concern.

Table S-7.--Proportion of historical and proposed range improvement costs funded by the Forest Service (percent)

Planning Area	Historical proportion	Proposed proportion
1	84	82
2	67	72
3	68	69
4	66	55
5A	77	52
5B	52	72
Northern Region	68	68

PUBLICATIONS CITED

Duran, G., and H. F. Kaiser.
1972. Range management practices: investment costs, 1970. 38 p. USDA Handb. 435, Washington D.C.

Lundgren, Allen L.
1971. Tables of compound-discount interest rate multipliers for evaluating forestry investments. USDA For. Serv. Res. Pap. NC-51, 142 p. North Central For. Exp. Stn., St. Paul, Minn.

Sassaman, R. W., and R. D. Fight.
1975. A tool for estimating the financial returns on forage grasses seeded in thinned ponderosa pine. J. Range Manage. 28(3):185-189.

U.S. Bureau of the Census.
1972. Census of agriculture, 1969, Volume 1, Area reports, part 38, Montana, Section 1 Summary. 272 p. U.S. Gov. Print. Off., Washington, D.C.

U.S. Bureau of the Census.
1973. Census of population, 1970, Volume 1, Characteristics of the population, Part 28, Montana. 536 p. U.S. Gov. Print. Off., Washington, D.C.

USDA Forest Service.
1976. Supplemental appendix, a recommended Renewable Resource Program, Forest Service, Washington, D.C.

APPENDIX A
Tables A-1 through A-6

Appendix Table A-1.--Proposed improvements, average unit costs, and expected additional grazing capacity for sampled allotments by National Forests in Planning Area 1.

Type of Improvement	Clearwater N.F.			Panhandle N.F.			Nezperce N.F.		
	cost/ unit	units	added capacity	cost/ unit	units	added capacity	cost/ unit	units	added capacity
STRUCTURAL	($)		AUM	($)		AUM	($)		AUM
A. 1	2,556	9		2,250	4	20	995	31	
2	417	6	82				1,000	1	420
3							5,250	2	
C. 7	500	7	58				478	9	1,037
F.15	1,200	4	58				200	1	96
G.16	157	7	37						
H.17	2,296	2.7		1,500	2.0	127	1,000	10.0	
18	1,543	7.0	200	1,667	3.0		1,182	5.5	790
19	827	15.0		1,574	4.7		925	35.5	
20	5,000	1.0							
I.22	5,000	--	6	11,000	--	0			
NONSTRUCTURAL									
J. 1	100	5	7						
K. 3	40	5					15	20	
4	5	2,000	117				20	1,400	966
6							10	200	
L. 7	10	5	255						259
8	17	2,800					52	500	
N.11	200	15							
12							50	200	
13	16	1,305	84	35	657	161	30	1,420	647
14	50	300							
O.15	10	100	2				20	25	4
Q.16	14,000	--	62	3,500	--	23			

Appendix Table A-2.--Improvements proposed for sampled allotments, average unit costs, and expected additional grazing capacity in Planning Area 2

Type of improvement	Bitterroot N.F.			Flathead N.F.		
	Cost/ unit	Units	Added capacity	Cost/ unit	Units	Added capacity
	Dollars		AUM	Dollars		AUM
STRUCTURAL						
A 1	1,762.50	8	33	1,700	8	1
2	1,000	4				
3						
C 6						
7	266.67	18	72			
E 13	1,250	2	51			
14	2,500	1				
F 15						
G 16						
H 17	2,000	5	252	1,890	5	122
18	3,186.21	14.5		1,890	7	
19	2,514.29	24.5				
20	2,000	.75				
NONSTRUCTURAL						
J 2	60	30	7			
K 4	15.71	565	32			
6	10	1,500				
L 7	1.67	1,500	29			
8	9	565				
M 9						
N 11	2	5,000	129			
12	10	300				
13						
14	25	74				
O 15	.70	250	0			
P 16						

Appendix Table A-2.--Continued

Type of improvement	Kootenai N.F. Cost/unit	Units	Added capacity	Lolo N.F. Cost/unit	Units	Added capacity
	Dollars		AUM	Dollars		AUM
STRUCTURAL						
A 1	876.79	14		1,205.27	11	25
2	40	1	316			
3	15,000	1				
C 6	300	1	25			
7	468.57	7		407.69	13	125
E 13				333.33	3	52
14	30,000	1	360			
F 15	333.33	3	93			
G 16				300	10	0
H 17				1,725	4	
18	2,118.75	16		1,225	4	
19	2,151.80	6.1	579	1,435.29	8.5	145
20	300	.1		1,000	.3	
NONSTRUCTURAL						
J 2				10	100	0
K 4						
6						
L 7						
8	4.94	3,400	368			
M 9						
N 11						
12				100	80	
13	5	90	51	15	300	136
14	200	2				
O 15						
P 16			0			22

Appendix Table A-2.--Continued

Type of improvement	Philipsburg R.D. Cost/unit (Dollars)	Philipsburg R.D. Units	Philipsburg R.D. Added capacity (AUM)	Lincoln R.D. Cost/unit (Dollars)	Lincoln R.D. Units	Lincoln R.D. Added capacity (AUM)
STRUCTURAL						
A 1	1,080	2	0	1,500	1	2
2				2,000	1	
3						
C 6				833.33	3	36
7	800	2	55	750	2	
E 13				4,916.67	.6	30
14						
F 15						
G 16						
H 17						
18	3,000	1	898	2,500	2	24
19	3,250	4		2,250	4	
20						
NONSTRUCTURAL						
J 2						
K 4						
6						
L 7						
8						
M 9	10	100	80			
N 11	20.50	200	70			
12				27	50	28
13				33.33	90	
14						
O 15						
P 16						

Appendix Table A-3.--Improvements proposed for sampled allotments, average unit costs, and expected additional grazing capacity by National Forests in Planning Area 3.

Type of improvement	Beaverhead N.F.			Lewis and Clark N.F.		
	Cost/ unit	Units	Added capacity	Cost/ unit	Units	Added capacity
	Dollars	Number	AUM	Dollars	Number	AUM
STRUCTURAL						
A 1	1,637.50	16	62	1,566.66	3	2
2	1,854.55	5.5		500	1	
B 4				1,100.00	2	59
5						
C 6	969.23	13	1,595	518.52	27	1,397
7	591.18	51		475.00	3	
8						
D 11	750	2	120	2,000.00	1	5
E 13	2,270.77	16.25	1,166	2,187.50	4	303
F 15	2,000.00	2	100	800.00	2	32
G 16	1,500.00	1	0			
H 17	2,454.55	11	1,423	2,225.00	4	1,161
18	1,916.67	37.2		1,538.15	16.25	
19	1,875.14	92.5		2,033.14	8.75	
20				1,625.00	1.2	
I 22				2,250.00	--	0
NONSTRUCTURAL						
J 1				7.83	230	21
3						
K 3	15.00	400	60			
5				10.00	100	35
6				9.23	130	
L 7	33.00	1,000	520			
8	4.16	6,250		38.46	130	11
N 11	4.21	6,775	1,731	6.67	300	336
13	12.94	7,030		8.20	800	
14	50	50				

Appendix Table A-3.--Continued

Type of improvement	Deerlodge N.F. Cost/ unit	Deerlodge N.F. Units	Deerlodge N.F. Added capacity	Helena N.F. Cost/ unit	Helena N.F. Units	Helena N.F. Added capacity
	Dollars	Number	AUM	Dollars	Number	AUM
STRUCTURAL						
A 1	1,750.00	4	140	2,000.00	3	21
2	500.00	3		333.33	1.5	
B 4						
5				1,357.14	7	166
C 6				636.36	11	259
7	500.00	6	528	500.00	4	
8	500.00	5				
D 11						
E 13	1,500.00	1	75			
F 15						
G 16						
H 17	975.00	4	1131			
18	4,000.00	1				
19	1,973.77	15.25		1,740.16	12.7	292
20						
I 22						
NONSTRUCTURAL						
J 1				20.00	200	15
3						
K 3						
5				5.00	200	15
6						
L 7				35.00	200	15
8						
N 11	12.00	100	228			
13	5.00	100		50.00	310	150
14						

Appendix Table A-4.--Improvements proposed for sampled allotments, average, unit costs and expected additional grazing capacity, in Planning Area 4

Type of improvement	Gallatin N.F.			Beartooth R.D.		
	Cost/ unit	Units	Added capacity	Cost/ unit	Units	Added capacity
	Dollars	Number	AUM	Dollars	Number	AUM
STRUCTURAL						
A 1	1,050	2	--	1,200	2	27
B 5	300	1	8			
C 6	400	3	199	500	3	53
7	404.5	11				
8	250	2				
E 13	433.33	3	20			
G 16				100	1	5
H 18	1,546.67	3.75	569	1,000	2.5	108
19	1,776.27	29.5				
20	2,000	.05				
NONSTRUCTURAL						
K 4	10	450	65			
L 8	6.84	475	90			
N 11	5	200	83			
13	9.31	1,450				
14	20	100				

Appendix Table A-5.--Improvements proposed for sampled allotments, average unit costs, and expected additional grazing capacity for Planning Areas 5A and 5B

Type of improvement	Planning Area 5A			Planning Area 5B		
	Cost/unit	Improvements	Added capacity	Cost/unit	Improvements	Added capacity
	Dollars	Number	AUM	Dollars	Number	AUM
STRUCTURAL						
A 1	1,275	20	10	1,490	20	0
B 5				809	11	713
C 6	940	29	430	1,000	1	601
7				1,100	6	
8	300	62		1,000	2	
D 10	5,846	13	2,448	500	4	2,368
11	13,614	14		9,359	29	
E 13	3,099	120.2	4,020	4,640	217.8	14,325
F 15	1,500	6	425	1,180	15	1,087
H 17	1,946	40.4	3,730	1,600	4	6,323
18	1,846	19.5		1,880	78.8	
19	1,807	47.7				
20	2,000	2.5				
NONSTRUCTURAL						
J 1				3	2,000	840
2				1	1,110	
K 5				2	2,000	458
6				2	1,000	
L 7				4	2,000	1,318
8	9	500	89	3	3,800	
M 10				5	1,900	286
N 11	3	2,500	303	12	380	24
13	12	200				
O 15				2	160	0

Appendix Table A-6.--Interest factors and average useful lives of range improvements in the Northern Region

Type of improvement	Planning Areas 1-4		Planning Areas 5A and 5B	
	10% Interest factor	Years	10% Interest factor	Years
STRUCTURAL				
A. Access[1/]	0.1023	40	0.1023	40
B-G. Water developments	.1061	30	.1061	30
H. Fences	.1102	25	.1061	30
I. Other structural[2/]	.1628	10	.1628	10
NONSTRUCTURAL				
J. Ground preparation[3/]	.2638	5	.2638	5
K. Seeding	.1061	30	.1061	30
L. Fertilization	.4021	3	.4021	3
M. Water retention	.1061	30	.1061	30
N. Plant control	.1315	15	.1102	25
O. Rodent control	.2638	5	.2638	5
P. Other nonstructural[4/]	1.1000	1	1.1000	1

Sources: Interest factors - Lundgren (1971, p. 115-128) and years - Duran and Kaiser (1972) except:

1/ Northern Region experience.
2/ Primarily private investments; maximum Forest Service permit is 10 years; usually depreciated for tax purposes within 10 years.
3/ Nearly all prescribed burning.
4/ Based on specific improvements indicated in sample.

APPENDIX B
Definitions

Structural Improvements

A. 1. Cattleguard--A device installed on roads, that livestock cannot cross, while vehicular traffic can pass over. It is usually made of rails, steel tubing, or lumber spaced to discourage livestock. Its size varies with the width of the road, and fences are joined to both sides.

A. 2. Stock Trail--A designated road, usually dirt, made for access to livestock in an area. Logging roads or other roads are often used for this purpose by permittees.

A. 3. Stock Bridge--An underpass or overpass for the cattle to move from one location to another without crossing a busy highway, railroad right-of-way, or stream. It may also be built to avoid mined areas or natural hazards.

B. 4. Trick Tank--Rainwater collecting device in arid and semiarid ranges.

B. 5. Pit Tank--Similar to the trick tank, collecting surface water in natural depressions, waterways, etc., for range livestock.

C. 6, 7, & 8. Spring Development--Spring development with different tanks made out of wood, metal, and plastic. Spring water fills the tank over a few days, providing the livestock with ample water during the grazing season.

D. 9 through 12. Well Development--Artesian, windmill, electric pump, etc., any device, which provides underground water supplies for the livestock grazing on the range.

E. 13 & 14. Water Transmission--Water transmission by pipeline or by ditch is closely related to well development. It avoids livestock travel to and from arid and semiarid ranges to the water source.

F. 15. Dam and Reservoir--An earthen dam constructed at low cost, in natural depressions or small watercourses. Most of these reservoirs cover less than an acre.

G. 16. Other Water Developments--Devices or man-made improvements (other than reservoirs) to provide water for livestock.

H. 17 through 21. Fence--Fencing defines an area to be grazed by a certain number of livestock. Fenced areas may be protected, used in a cycle of rest and rotation, or used to protect water sources and right-of-ways. Boundaries of a National Forest and allotments may also be delineated by fences.

I. 22. Others, Not Listed--Structural improvements in this category are mainly built by permittees--cabins, corrals, loading chutes, and barns. None of these items was reported as a proposed improvement in this grazing survey.

Nonstructural Improvements

J. 1. Ground Preparation - Plowing--Preparation for seeding often requires the removal of certain vegetation and loosening the soil.

J. 2. Ground Preparation - Burning--Burning undesirable vegetation on the range before seeding is sometimes done to promote seed germination and early growth.

K. 3 through 6. Seeding--Different kinds of seeding may be used to establish a good range at different costs. Ground seeding may cost more than air seeding, if large areas are to be covered. Normal seeding with drills is also expensive. Interseeding different species into native grass may have the same effect and cost less.

L. 7 & 8. Fertilization--Two different kinds of fertilization are listed in this survey, one being used with the seeding to establish the range, while the other is used to increase growth of existing forage.

M. 9 & 10. Water Retention--Using the contours of the land aided by ditches, pits, etc., snowmelt or rainwater can be spread over a large area. Pitting is closely related to the rainwater collecting device in Group b, but natural depressions are used to collect the water.

N. 11 through 14. Plant Control--Removal of undesirable vegetation from ranges and seeding them with native or other forage plants is the main device to increase forage for livestock in semiarid country. Plant control may include removal of selected vegetation, removal of brush, and controlling poisonous plants.

O. 15. Poisoning, Rodent Control--Rodents reduce vegetation and create hazards for livestock. Poisoning may remove the rodents.

Horvath, Joseph C., Dennis L. Schweitzer, and Enoch F. Bell.
1978. Grazing on National Forest System lands: costs of increasing capacity in the Northern Region. USDA For. Serv. Res. Pap. INT-215, 56 p. Intermt. For. and Range Exp. Stn., Ogden, Utah 84401.

Feasibility of increasing grazing capacity through additional range improvements was investigated in the Northern Region of the USDA Forest Service. Sample grazing allotments on representative Ranger Districts were evaluated by questionnaire. Results of the survey included estimates of additional livestock that could be grazed, cost of additional improvements, and value of existing improvements.

KEYWORDS: range improvements, grazing capacity, range management, costs.

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Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Field programs and research work units are maintained in:

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